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NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP), SUBPART H; RADIONUCLIDES POTENTIAL-TO-EMIT CALCULATIONS

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

FLUOR®
P.O. Box 1000
Richland, Washington

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NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS (NESHAP), SUBPART H; RADIONUCLIDES POTENTIAL-TO-EMIT CALCULATIONS

EXECUTIVE SUMMARY

This document provides an update of the status of stacks on the Hanford Site and the potential radionuclide emissions, i.e., emissions that could occur with no control devices in place. This review shows the calculations that determined whether the total effective dose equivalent (TEDE) received by the maximum public receptor as a result of potential emissions from any one of these stacks would exceed 0.1 millirem/year. Such stacks require continuous monitoring of the effluent, or other monitoring, to meet the requirements of Washington Administrative code (WAC) 246-247-035(1)(a)(ii) and WAC 246-247-075(1), –(2), and –(6). This revised update reviews the potential-to-emit (PTE) calculations of 31 stacks for Fluor Hanford, Inc. Of those 31 stacks, 11 have the potential to cause a TEDE greater than 0.1 mrem/year.

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ACRONYMS

ANSI	American National Standards Institute
CAA	Clean Air Act
CAM	continuous air monitoring
CFR	Code of Federal Regulations
CSB	Canister Storage Building
CVDF	Cold Vacuum Drying Facility
DF	decontamination factor
DOE-RL	U.S. Department of Energy, Richland Operations Office
EPA	U.S. Environmental Protection Agency
FFTF	Fast Flux Test Facility
FH	Fluor Hanford, Inc.
HEPA	high-efficiency particulate air
MEI	maximum exposed individual
MPR	maximum public receptor
NDA	nondestructive assay
NESHAP	National Emission Standards for Hazardous Air Pollutants
PFP	Plutonium Finishing Plant
PUREX	Plutonium Uranium Reduction Extraction
REDOX	Reduction Oxidation
TEDE	Total Effective Dose Equivalent
WAC	Washington Administrative Code
WDOH	Washington Department of Health
WESF	Waste Encapsulation and Storage Facility
WRAP	Waste Receiving and Processing

METRIC CONVERSION CHART

Into metric units			Out of metric units		
If you know	**Multiply by**	**To get**	**If you know**	**Multiply by**	**To get**
Length			**Length**		
inches	25.40	millimeters	millimeters	0.03937	inches
inches	2.54	centimeters	centimeters	0.393701	inches
feet	0.3048	meters	meters	3.28084	feet
yards	0.9144	meters	meters	1.0936	yards
miles (statute)	1.60934	kilometers	kilometers	0.62137	miles (statute)
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.09290304	square meters	square meters	10.7639	square feet
square yards	0.8361274	square meters	square meters	1.19599	square yards
square miles	2.59	square kilometers	square kilometers	0.386102	square miles
acres	0.404687	hectares	hectares	2.47104	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.34952	grams	grams	0.035274	ounces (avoir)
pounds	0.45359237	kilograms	kilograms	2.204623	pounds (avoir)
tons (short)	0.9071847	tons (metric)	tons (metric)	1.1023	tons (short)
Volume			**Volume**		
ounces (U.S., liquid)	29.57353	milliliters	milliliters	0.033814	ounces (U.S., liquid)
quarts (U.S., liquid)	0.9463529	liters	liters	1.0567	quarts (U.S., liquid)
gallons (U.S., liquid)	3.7854	liters	liters	0.26417	gallons (U.S., liquid)
cubic feet	0.02831685	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.7645549	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Energy			**Energy**		
kilowatt hour	3,412	British thermal unit	British thermal unit	0.000293	kilowatt hour
kilowatt	0.94782	British thermal unit per second	British thermal unit per second	1.055	kilowatt
Force/Pressure			**Force/Pressure**		
pounds (force) per square inch	6.894757	kilopascals	kilopascals	0.14504	pounds per square inch

06/2001

Source: *Engineering Unit Conversions*, M.R. Lindeburg, PE., Third Ed., 1990, Professional Publications, Inc., Belmont, California

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1.0 INTRODUCTION

The U.S. Department of Energy, Richland Operations Office (DOE-RL), is a department, agency, or instrumentality of the executive branch of the federal government and must comply with the requirements of the *Clean Air Act* (CAA) *of 1990 and Amendments* and the implementing regulations. On December 15, 1989, the U.S. Environmental Protection Agency (EPA) promulgated in the Code of Federal Regulations (CFR) the "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities" (40 CFR Part 61, subpart H). Subpart H requires that the combined emissions of radionuclides from any DOE facility (site) shall not exceed those amounts that would cause any member of the public to receive a total effective dose equivalent (TEDE) of 10 mrem in a year. The Subpart H requirements for continuous measurement of emissions from stacks, vents, or other point sources specify that such requirements are contingent on the potential for emissions from each source. The potential emissions, or potential-to-emit (PTE) at each point source, are evaluated by estimating the effluent radionuclide release rates that would result if all pollution equipment did not exist, but the facilities operations were otherwise normal.

This document provides updates (where applicable) for 31 stacks on the Hanford Site under management of Fluor Hanford, Inc. (FH). The stacks managed by CH2M HILL Hanford Group, Inc. and Pacific Northwest National Laboratory are not included. This review also confirms those stacks requiring continuous monitoring (i.e., those providing a TEDE from potential emissions >0.1 mrem/year to the maximally exposed individual [MEI], both as defined by 40 CFR 61 subpart H, and as adopted with further stringency in the Washington Administrative Code [WAC] 246-247). Recent calculations are included, but no new calculations were performed specifically for this report.

2.0 SCOPE

This document provides the current PTE calculations for all powered ventilated stacks with the potential for radionuclide emissions (Appendix A, Table A-1) under management by FH.

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3.0 METHODS FOR CALCULATING POTENTIAL STACK RADIONUCLIDE AIR EMISSIONS

Potential emissions for the stacks were calculated using one of the following five methods:

1. Annual Possession Quantity estimation combined with release factors specified in WAC 246-247-030(21)(a)
2. Back-calculations based on measured emission rates and in situ measurements of the control equipment efficiencies, as approved by the Washington Department of Health (WDOH); for high efficiency particulate air (HEPA) filters, a decontamination factor of $3{,}000^n$, where n equals the number of HEPA filter banks in series, is typically used
3. Nondestructive assay (NDA) as approved by WDOH
4. Measurement of the quantities of radionuclides captured in each control device, coupled with in situ measurements of the control equipment efficiencies, as approved by WDOH
5. Spill release fraction (no longer used or discussed).

Calculations based on the first two methods are usually considered overly conservative, while the calculations made using the last three methods should produce more realistic estimates of potential emissions (Davis and Barnett 1994 and Barnett and Davis 1996). It is important to note that all in-line control devices experiencing directional airflow upstream of the HEPA filters, as well as the HEPA filters themselves, must be included in the assessment of potential emissions. For example, stack emissions based on release factors from Appendix D or from back-calculations could indicate that the potential emissions would result in a TEDE exceeding 0.1 mrem/year to the MEI. For the same stack, calculations using one of the latter methods could result in an TEDE estimate of less than 0.1 mrem/year to the MEI. If this occurs, the latter methods' results would be preferable since they would allow avoidance of excessive monitoring requirements driven by overly conservative results.

3.1 APPENDIX D RELEASE FACTORS

The PTE for a system can be estimated based on release factors presented in WAC 246-247-030(21)(a): gases = 1, liquids or particulate solids = 1.0E–03, and solids = 1.0E–06.

It should be noted that using these release fractions for liquids or particulate solids is extremely conservative for most situations, because research involving liquids and loose particulates has demonstrated release fractions orders of magnitude less than the 1.0E–03 release fraction for indoor (stagnant air) activities (DOE-HDBK-3010-94). For example, a spill of powder from a 1 m height resulted in a 4.0E–05 release fraction for material of 10 μm and smaller particle size diameters (Note: this was the maximum release fraction observed in the experiment). Likewise, a liquid spill from a 3 m height resulted in a 4.0E–05 release fraction. For each of these cases, the release fraction is orders of magnitude less than the 1.0E–03 release fraction used for particulate solids and liquids from WAC 246-247-030(21)(a).

3.2 BACK-CALCULATIONS BASED ON A DECONTAMINATION FACTOR OF 3,000^n

This method for estimating potential emissions assumes *The Nuclear Air Cleaning Handbook* (DOE-HDBK-1169-2003) decontamination factor (DF) of 3,000 [DF = 1/(1.0 - 0.9997)] for a HEPA filter. The method assumes that each bank in series acts independently of a preceding bank and will remove contamination with the same 3,000 decontamination factor. For a system with n banks of HEPA filters in series, the decontamination factor is $3{,}000^n$. This method is excessively conservative for a contaminated system. When processing no longer occurs, the resuspension of residual contamination downstream of the HEPA filters can dominate the small airborne releases from a facility. Multiplying these releases by $3{,}000^n$ will overestimate the potential emissions by orders of magnitude (Barnett and Davis 1996). It is recommended the measured emissions from the previous four years are averaged and multiplied by $3{,}000^n$ to provide the potential emissions. A more detailed discussion is provided on page A1-1.

3.3 NONDESTRUCTIVE ASSAY

The NDA method provides a technical basis for measuring potential emissions (Barnett and Davis 1996). NDA measures gamma decay of the curie content of the HEPA filters and prefilters. By performing the NDA in the same geometry as the filters, the curie content on the filters can be calculated. It is assumed that the contents would be released to the atmosphere, annualized over the time the filters were in place. Annual release rates for non-gamma-emitting radionuclides are calculated using ratios obtained from actual radionuclide emissions measurements or inventory data. Also, in a facility with no current operations, where the HEPA filters have not been changed out since processing occurred, the curie content of the HEPA filters might unduly reflect the potential release rates of earlier years involving processing.

3.4 AIR CONCENTRATION MEASUREMENTS UPSTREAM OF HEPA FILTER

The upstream air concentrations provide direct information on the potential emissions from a facility. This method can be applied by using continuous air monitoring (CAM) data, inserting an air sample probe for upstream measurements, or radiological analysis of removed HEPA filters and other upstream control devices. CAM data can be used if the data are taken from the process area, which contains the radionuclide inventory. Air measurements also might be collected in the ventilation system upstream of the HEPA filters and other upstream control devices. In this case, a sampling port is selected, a probe inserted, and air concentrations are measured. The final method is the sampling of the furthest upstream HEPA filters for the facility. In this case, one or more HEPA filters are removed and the radiological content analyzed either by destructive assay or by a gamma spectrometer assay. The airflow during the time the HEPA filter is on line is used to determine the annual release rate. These methods all are technically based in that the measurements represent the potential concentrations emitted from a facility without control devices, but with operations otherwise normal.

4.0 CAP88 PC DOSE MODELING

Dose-per-unit curie release factors (DOE/RL-2006-29) were computed using the EPA-approved CAP88-PC model (EPA 1990). This model incorporates plume rise from the stack based on the flow rate and stack diameter. After leaving the stack, the plume dispersion is modeled based on data reflecting historical meteorological conditions. The modeled concentrations in the plume are usually adjusted by dry deposition (dry deposition velocity = 1.8 cm/s) and wet deposition, but wet deposition is ignored because of the low incidence of precipitation at the Hanford Site. The modeled concentrations are used to calculate a TEDE for a maximum public receptor (MPR) (refer to §4.2). A complete description of the modeling is provided in DOE/RL-2006-29.

Versions of CAP88 PC before version 3 use an algorithm that overstates the contributions from daughter products, which is particularly noticeable in the ^{137}Cs decay chain. The result is that ^{137}Cs appears to have a greater biological impact on the receptor than, e.g., ^{90}Sr. As a result, some of the notices of construction and subsequent approvals in the air operating permit call for sampling of ^{137}Cs instead of ^{90}Sr. This situation does not represent any significant error in resultant estimation of emissions, and it may be rectified when the stacks are reassessed using version 3 or a later version.

4.1 MAXIMALLY EXPOSED INDIVIDUAL

The MEI is a real or hypothetical member of the public at a location either on or off the Hanford Site at which public access is unrestricted. The MEI hypothetically incurs the maximum radiological dose from all measured radionuclide emissions released from the Hanford Site during a calendar year. The MEI dose due to actual emissions is used for assessing compliance with federal and state dose standards. The CAP88 dose model is operated with meteorology data for the year being assessed when determining dose to the MEI for reporting purposes and determining compliance with the public dose standards.

Because this meteorological data cannot be predicted, CAP88 dose modeling for PTE dose estimation uses data representing average meteorological conditions of the previous 10 years (e.g., 10 year average). Also, because of changing access to the site, with new unrestricted locations being identified and allowing for onsite exposure to the public, a new definition for computing dose, i.e., maximum public receptor (MPR), is now used, as discussed in the next section.

4.2 MAXIMUM PUBLIC RECEPTOR

MPRs were established for each of the currently defined 11 emission zones on the Hanford Site (DOE/RL-2006-29). Whether those receptors are located onsite or offsite depends on the point of maximum public exposure modeled for each of the 11 zones . MPRs may include employees working at locations on the Hanford Site leased or owned by companies not affiliated with the DOE or its contractors.[1] Facilities at which MPRs work are further defined as affording

[1] The maximum public receptor is defined as an individual whose residence location, work location, and lifestyle maximize the dose from airborne pathways. In previous years, this maximum public receptor was considered to be a resident living across the Columbia River from the 300 Area, at the location of maximum exposure.

unrestricted access to any member of the public. All MPRs are assumed to be at their locations 24 hours a day, every day of the year.

Dispersion factors for particulate, volatile, and gaseous radionuclide emissions, based on multi-year meteorological data, are used to determine MPR locations. The geographic directions for the dispersion factors are identified within each emission zone. Distance from a central release point within the emission zone to potential MPRs is also a factor. The MPRs are those locations at which the highest possible dose is postulated, using a combination of dispersion factors and distance to a potential MPR, along with other CAP88-PC parameters, such as inhalation, exposure, and ingestion rates.

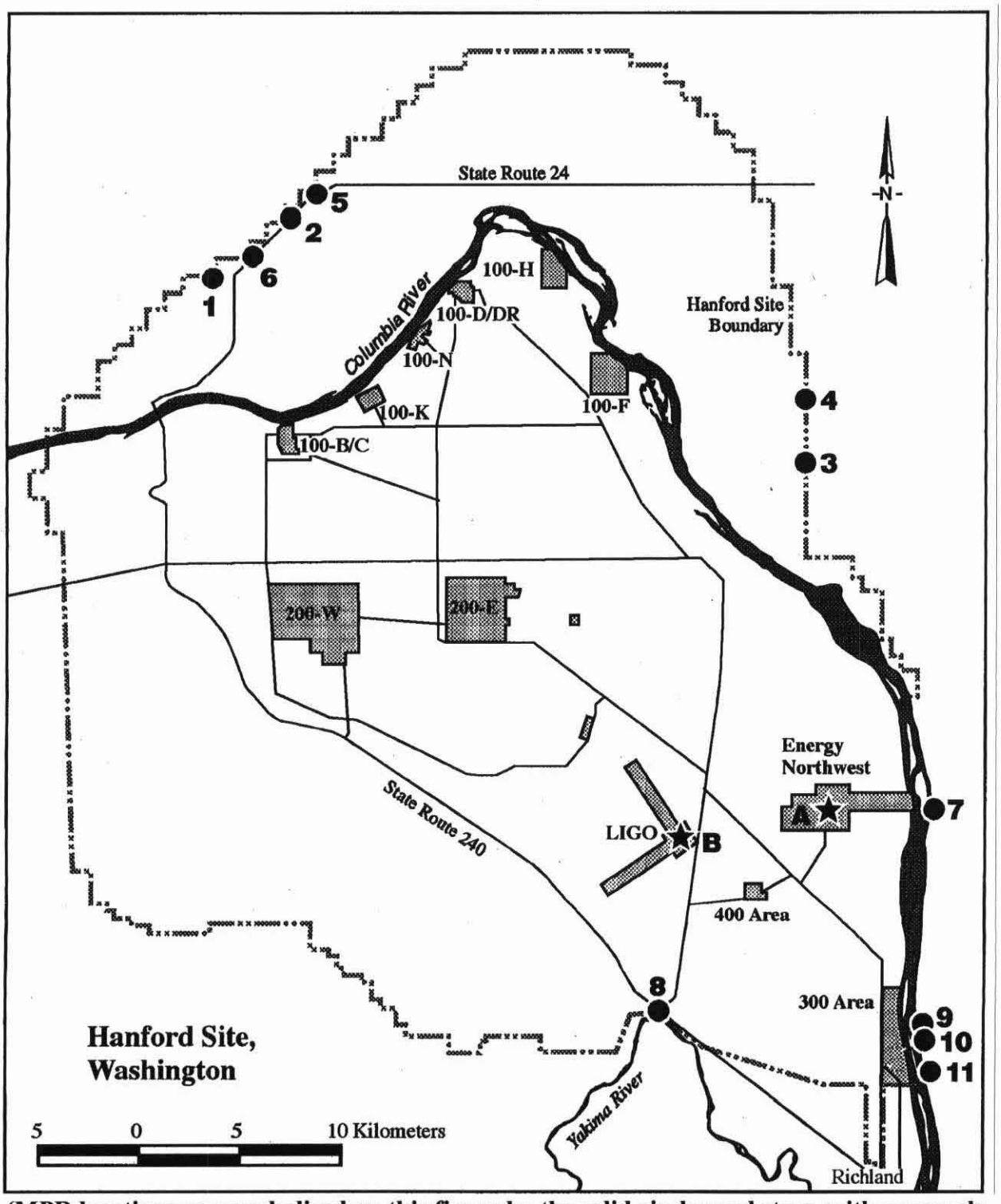
Offsite MPR locations are always at or beyond the Hanford Site boundary, where the potential exists for full occupancy by a member of the public. Possible onsite MPR locations currently involve two locations, the Energy Northwest facility and the Laser Interferometer Gravitational Wave Observatory (LIGO). Determining the MPR location that is applicable to an emission zone depends on the combination of all parameters.

Three of the 11 emission zones have unit dose conversion factors for two potential MPRs each; refer to Figures 1 and 2 and Table 1. These emission zone MPRs are determined by the radionuclide airborne emissions being modeled. The radionuclide mix might vary according to the potential source of radionuclides. This means the MPR for one activity at a given location may be onsite, while the MPR may be offsite for another activity at the same location due to its emitting a different mix of radionuclides. For the eight emission zones (all 100 or 300 Area zones) that each have only a single MPR (offsite in every case), the offsite MPR dose factors for every radionuclide in the CAP88-PC library were greater than the respective onsite dose factors, which negated a need to have onsite factors listed.

4.3 UNIT DOSE

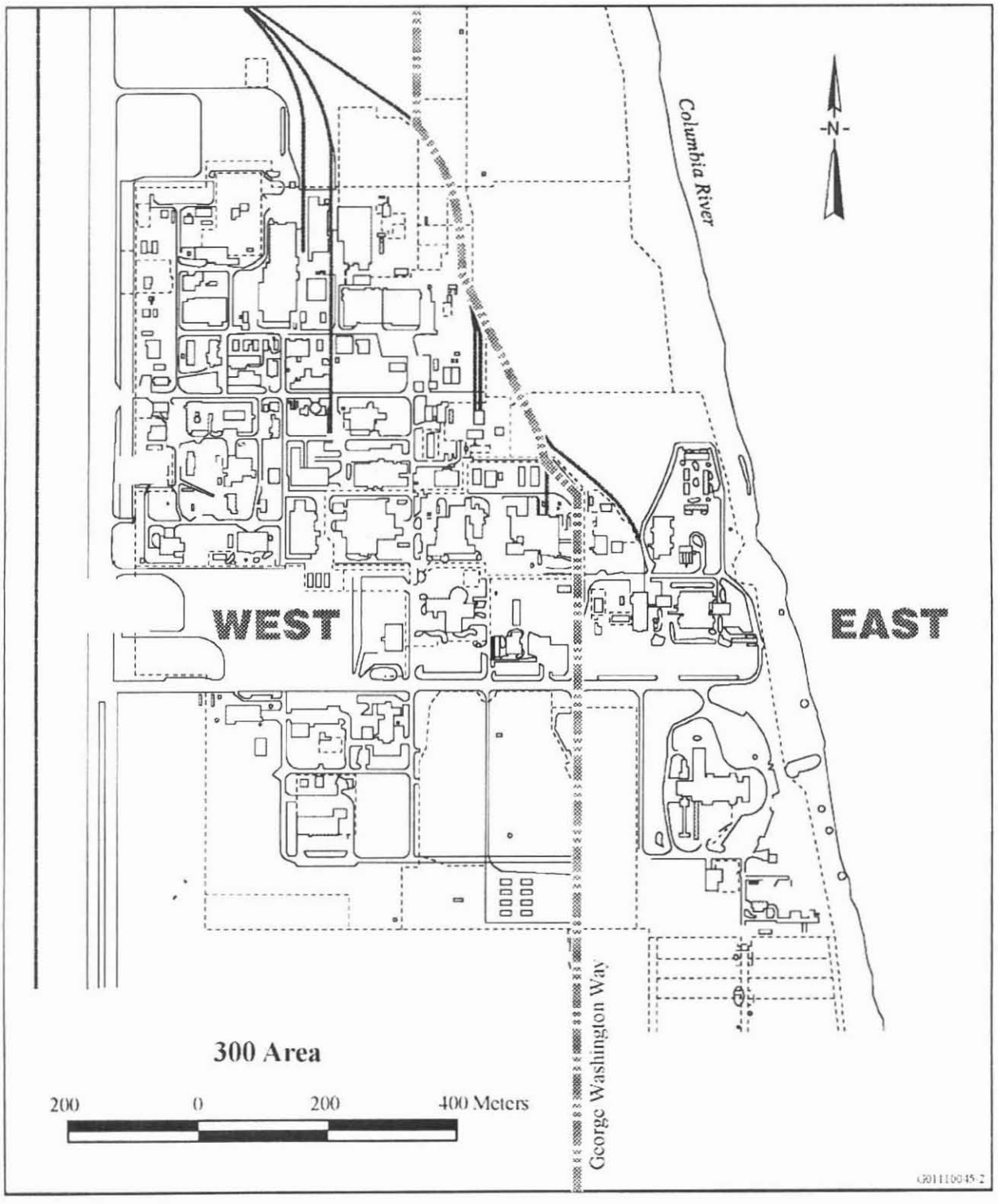
Unitized source terms and the length of time that meteorological data represented were calculated for each of the major areas onsite (DOE/RL-2006-29). In addition, DOE/RL-2006-29 assumed two stack release heights, ≥ 40 m and < 40 m, for the dose calculations.

One of the five methods noted in §3.0 was applied to each of the stacks to produce a potential release rate for each stack. (A complete list of the radionuclides with unit curie emissions is provided on individual stack worksheets in Appendix A.) The location of the source and the stack height were used to select the appropriate dose-per-unit-curie release factor from DOE/RL-2006-29 (or its predecessor). These factors with the potential release rate were used to compute a TEDE to the MPR.



(MPR locations are symbolized on this figure by the solid circles and stars, with numerals and letters alongside them, respectively.)

Figure 1—Hanford Site Map of Emission Zones



Indicates the boundary between emission zones

Figure 2—300 Area Map of Emission Zones

Table 1—Direction and Distance to Each MPR Location from Respective Emission Zone

Emission Zone (Building or Facility)	Offsite MPR			Onsite MPR[a]		
	Map ID from Figures 1 and 2	Direction	Distance (m) [b]	Map ID from Figures 1 and 2	Direction	Distance (m) [b]
100-B/C (105-B building)	1	NNW	8,600	N/A	N/A	N/A
100-D/DR (105-D building)	2	WNW	8,900	N/A	N/A	N/A
100-F (105-F building)	3	ESE	9,700	N/A	N/A	N/A
100-H (105-H building)	4	ESE	11,600	N/A	N/A	N/A
100-K (105-KW building)	5	NNW	8,900	N/A	N/A	N/A
100-N (105-N building)	6	WNW	8,500	N/A	N/A	N/A
200-E (PUREX facility)	7	ESE	20,200	A	ESE	16,630
200-W (REDOX facility)	8	SE	22,000	B	ESE	18,310
300-E (331 building)	9	NE	1,100	N/A	N/A	N/A
300-W (324 building)	10	NE	1,400	N/A	N/A	N/A
400 Area (FFTF facility)	11	SE	9,100	A	NNE	4,390

[a] The unit dose factors of offsite MPRs for emission zones 100-B/C, 100-D/DR, 100-F, 100-H, 100-K, 100-N, 300-E, and 300W are greater than the factors of potential onsite MPRs.

[b] These values represent the shortest distance from the respective point of release to the Hanford Site boundary in the prevalent wind sector of the wind rose.

ID = identification N/A = not applicable FFTF = Fast Flux Test Facility
PUREX = Plutonium Uranium Reduction Extraction REDOX = Reduction Oxidation

When the PTE TEDEs for the stacks were compared to the >0.1 mrem/yr TEDE criterion identifying major stacks, 11 stacks were identified as major stacks.

5.0 RESULTS OF DOSE CALCULATIONS

Results of the dose calculations are provided in Appendix A (see Table A-1) for each stack. The 11 major stacks with potential for emissions resulting in a TEDE to the MPR of >0.1 mrem/year, and which therefore require major stack monitoring, are listed in Table 2.

Table 2—Major Stacks

Stack number	Facility	Number of HEPA stages	Page
IWTS Air Sparger	105-KW Basin	1	A1-3
296-K-142	CVDF	2	A1-5
291-A-1	PUREX Plant	3[a]	A2-1
296-B-1	B Plant	2	A2-3
296-B-10	WESF	2	A2-4
296-H-212	CSB	2	A2-5
296-P-31	209-E	2	A2-8
291-Z-1	PFP	1	A3-1
296-Z-7	PFP	2	A3-4
291-T-1	T Plant	2	A3-7
296-W-4	WRAP Facility	2	A3-10

[a] One deep-bed fiberglass filter plus two HEPA filters in series

CSB = Canister Storage Building
CVDF = Cold Vacuum Drying Facility
IWTS = Integrated Water Treatment System
KW = 105K West
PFP = Plutonium Finishing Plant
PUREX = Plutonium Uranium Reduction Extraction
WESF = Waste Encapsulation and Storage Facility
WRAP = Waste Receiving and Processing

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APPENDIX A

STACK CALCULATIONS

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STACK CALCULATIONS

Table A-1 provides a summary of the calculation worksheets included in this appendix for each of the stacks. The most current calculation worksheets for each FH stack listed in Table A-1 has been included in this appendix.

The headings on each worksheet indicate whether a release factor from WAC 246-247-030(21)(a), back-calculation, or other methodology was used to perform the assessment. When a worksheet using a release factor from WAC 246-247-030(21)(a) is used, the annual possession quantity (APQ) is provided and the release factor is applied to the APQ to provide the estimated PTE.

For back-calculations, the annual air concentrations were multiplied by a factor that represents the efficiency of each filter in the stream. For the case of a HEPA filter factor of 3000, the air concentration is multiplied by 3000^n, where *n* indicates the number of banks of HEPA filters in series. Where a prefilter or other type of filter exists, the annual air concentration would also be multiplied by that filter's efficiency factor, e.g., a prefilter factor (3 to 20). The results are the estimates of potential emissions.

The worksheet for nondestructive assay provides the curie content collected on the HEPA filters and the potential annual emissions. From the curie content, an average annual emission was estimated.

For all of the calculations, once the potential emissions were estimated, the CAP88 model was applied with an appropriate source release height and location. The CAP88 model used multi-year Hanford Site coverage meteorology for transport and diffusion to produce a TEDE to the onsite or offsite MPR

Appendix A is divided into the following six sections:

- A1 100 Areas
- A2 200 East Area
- A3 200 West Area
- A4 300 Area
- A5 400 Area
- A6 600 Area.

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Table A-1—FH Stacks

Stack	Page	HEPA Stages	Offsite PTE (mrem/yr)	Approved NESHAP Calculation Method	WDOH EU ID	Reference	Stack Status
100 AREAS							
105-KW Basin	A1-1	0	3.71E–03	Approved Alternative Release factors	CERCLA	DOE/RL-97-28 Rev. 2	Minor
IWTS Air Sparger (105-KW Basin)	A1-3	1	1.18E+02	Destructive analysis of the 2nd HEPA filter	CERCLA	DOE/RL-98-02 Rev. 0	Major
1706-KE	A1-4	1-2	2.3E–08	Release factors	168	FH-0801164	Minor
296-K-142 (CVDF)	A1-5	2	1.27E+01	Release factors	436	DOE/RL-96-110 Rev. 1	Major
200 EAST AREA							
PUREX Plant							
291-A-1	A2-1	3[a]	8.62E+05	Back calculation	369	HNF-1974 Rev. 1[b]	Major
296-A-10	A2-2	1	7.80E–04	NDA	384	Corr. No. 9956763	Minor
B Plant							
296-B-1	A2-3	2	7.87E+01	Release factors	402	DOE/RL-97-17 Rev. 0	Major
WESF							
296-B-10	A2-4	2	2.11E+01	Release factors	340	HNF-1974 Rev. 1[b]	Major
Canister Storage Building							
296-H-212	A2-5	2	3.64E+01	Release factors	435	HNF-7880 Rev. 0	Major
200 Area Effluent Treatment Facility							
296-E-1	A2-7	1[c]	3.89E–02	Release factors	301	03-RCA-0074	Minor
209-E Criticality Laboratory							
296-P-31	A2-8	2	1.07E+00	Release factors		FH-0801164	Major
200 WEST AREA							
Plutonium Finishing Plant							
291-Z-1	A3-1	1	3.50E+02	Release factors	393	DOE/RL-2003-43 Rev. 1	Major
296-Z-5	A3-2	2	5.5E–02	Release factors	389	DOE/RL-2000-42 Rev. 3	Minor
296-Z-6	A3-3	1	5.5E–02	Release factors	390	DOE/RL-2000-42 Rev. 3	Minor
296-Z-7	A3-4	2	5.42E+02	Release factors	503	DOE/RL-2003-43 Rev. 1	Major
296-Z-15	A3-5	1	7.9E–02	Release factors	CERCLA	DOE/RL-2003-43 Rev. 0	Minor
REDOX Facility							
291-S-1	A3-6	1	2.14E–03	Back calculation	332	FH-0801164.1	Minor
T Plant Complex							
291-T-1	A3-7	2	1.2E+02	Release factors	314	DOE/RL-2004-50 Rev. 0	Major
296-T-7	A3-8	1	7.5E–02	Release factors	315	WDOH 05042006	Minor

Table A-1—FH Stacks

Stack	Page	HEPA Stages	Offsite PTE (mrem/yr)	Approved NESHAP Calculation Method	WDOH EU ID	Reference	Stack Status
U Plant							
291-U-1	A3-9	1	2.04E–02	Back calculation	310	FH-0801164.1	Minor
WRAP Facility							
296-W-4	A3-10	2	1.13E+02	Release factors	193 & 486	DOE/RL-2000-34 Rev. 1	Major
300 AREA							
340-B BLDG	N/A	1	N/A	N/A	N/A	Not in use	Minor
340-DECON	A4-1	2	6.3E–06	Release factors	422	HNF-2936 Rev. 0	Minor
340-NT-EX	A4-2	2	3.6E–03	Release factors	423	EC300-03-02	Minor
400 AREA							
FFTF-CB-EX	A5-1	0	1.23E–04	Release factors	397	DOE/RL-2006-49 Rev. 0	Minor
FFTF-RE-SB	A5-2	0	3.55E–06	Release factors	395	Not in use	Minor
FFTF-HT-TR	A5-3	0	1.65E–07	Release factors	396	DOE/RL-2006-49 Rev. 0	Minor
437-1-61	A5-4	1	1.96E–07	NDA	399	DOE/RL-2006-49 Rev. 0	Minor
437-MN&ST	A5-5	1	5.14E–03	NDA	385	DOE/RL-2006-49 Rev. 0	Minor
600 AREA							
696-W-1	A6-1	2	2.71E–03	Release factors	62	DOE/RL-2000-04 Rev. 0	Minor
696-W-2	A6-2	2	2.71E–03	Release factors	63	DOE/RL-2000-04 Rev. 0	Minor

[a] One deep-bed fiberglass filter plus two HEPA filters in series

[b] Grandfathered; no NOC required

c Vessel off-gas vents to building ventilation through one of two sets of two HEPA filters in series; building ventilation exhausts through one HEPA filter in three parallel trains, two of which must be operating

CY = calendar year
HEPA = high-efficiency particulate air
NDA = nondestructive assay
NESHAP = National Emission Standards for Hazardous Air Pollutants
PUREX = Plutonium-Uranium Extraction Plant
REDOX = Reduction Oxidation
WESF = Waste Encapsulation and Storage Facility

A1 100 AREAS

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105 KW BASIN TABLE 7.1 SOURCE TERM							
Radionuclide	Inventory (Ci)	Release Fraction	Adjusted Release Fraction	Unabated based on water at (30 uCi/L Cs-137) Emission (Ci)	CAP-88 Dose Conversion Factor (mrem/Ci)	Unabated based on water at (30 uCi/L Cs-137) TEDE to the MEI (mrem/yr)	Dose percent of total
H-3	1.91E+04	6.00E-05	1.00E+00	1.15E+00	4.90E-05	5.62E-05	1.51E+00
C-14	3.31E+02	3.70E-11	1.00E+01	1.22E-07	3.80E-03	4.65E-10	1.25E-05
Fe-55	9.77E+02	3.70E-11	1.00E+01	3.61E-07	4.50E-04	1.63E-10	4.38E-06
Co-60	2.22E+03	3.70E-11	1.00E+01	8.21E-07	4.90E-01	4.02E-07	1.08E-02
Ni-59	1.99E+01	3.70E-11	1.00E+01	7.36E-09	6.10E-04	4.49E-12	1.21E-07
Ni-63	2.19E+03	3.70E-11	1.00E+01	8.10E-07	5.20E-04	4.21E-10	1.14E-05
Se-79	4.28E+01	3.70E-11	1.00E+01	1.58E-08	2.60E-01	4.12E-09	1.11E-04
Kr-85	3.15E+05	6.00E-05	1.00E+00	1.89E+01	1.10E-07	2.08E-06	5.60E-02
Sr-90	5.22E+06	3.70E-11	1.00E+01	1.93E-03	2.20E-01	4.25E-04	1.15E+01
Y-90	5.22E+06	3.70E-11	1.00E+01	1.93E-03	6.80E-04	1.31E-06	3.54E-02
Zr-93	2.01E+02	3.70E-11	1.00E+01	7.44E-08	2.60E-03	1.93E-10	5.21E-06
Nb(m)-93	1.20E+02	3.70E-11	1.00E+01	4.44E-08	4.10E-03	1.82E-10	4.91E-06
Tc-99	1.43E+03	3.70E-11	1.00E+01	5.29E-07	3.50E-04	1.85E-10	4.99E-06
Ru-106	5.76E+02	3.70E-11	1.00E+01	2.13E-07	3.10E-02	6.61E-09	1.78E-04
Rh-106	5.76E+02	3.70E-11	1.00E+01	2.13E-07	8.20E-22	1.75E-28	4.71E-24
Pd-107	7.68E+00	3.70E-11	1.00E+01	2.84E-09	7.40E-04	2.10E-12	5.67E-08
Cd(m)-113	1.78E+03	3.70E-11	1.00E+01	6.59E-07	2.60E-01	1.71E-07	4.62E-03
Sn(m)-121	3.98E+01	3.70E-11	1.00E+01	1.47E-08	1.11E-01	1.63E-09	4.41E-05
Sn-126	7.50E+01	3.70E-11	1.00E+01	2.78E-08	9.30E-02	2.58E-09	6.96E-05
Sb-125	1.85E+04	3.70E-11	1.00E+01	6.85E-06	5.20E-02	3.56E-07	9.59E-03
Sb-126	1.05E+01	3.70E-11	1.00E+01	3.89E-09	6.50E-03	2.53E-11	6.81E-07
Sb(m)-126	7.50E+01	3.70E-11	1.00E+01	2.78E-08	2.35E-06	6.52E-14	1.76E-09
Te(m)-125	4.50E+03	3.70E-11	1.00E+01	1.67E-06	2.00E-03	3.33E-09	8.98E-05
I-129	3.11E+00	6.00E-05	1.00E+00	1.87E-04	2.40E-01	4.48E-05	1.21E+00
Cs-134	1.03E+04	3.70E-11	1.00E+01	3.81E-06	2.00E-01	7.62E-07	2.05E-02
Cs-135	3.79E+01	3.70E-11	1.00E+01	1.40E-08	8.70E-03	1.22E-10	3.29E-06
Cs-137	6.71E+06	3.70E-11	1.00E+01	2.48E-03	5.30E-02	1.32E-04	3.55E+00
Ba(m)-137	6.34E+06	3.70E-11	1.00E+01	2.35E-03	2.40E-09	5.63E-12	1.52E-07
Ce-144	2.28E+02	3.70E-11	1.00E+01	8.44E-08	2.50E-02	2.11E-09	5.68E-05
Pr-144	2.26E+02	3.70E-11	1.00E+01	8.36E-08	4.30E-07	3.60E-14	9.69E-10

105 KW BASIN TABLE 7.1 SOURCE TERM							
Radionuclide	Inventory (Ci)	Release Fraction	Adjusted Release Fraction	Unabated based on water at (30 uCi/L Cs-137) Emission (Ci)	CAP-88 Dose Conversion Factor (mrem/Ci)	Unabated based on water at (30 uCi/L Cs-137) TEDE to the MEI (mrem/yr)	Dose percent of total
Pr(m)-144	2.74E+00	3.70E-11	1.00E+01	1.01E-09	2.20E-08	2.23E-17	6.01E-13
Pm-147	2.42E+05	3.70E-11	1.00E+01	8.95E-05	2.10E-03	1.88E-07	5.07E-03
Sm-151	8.69E+04	3.70E-11	1.00E+01	3.22E-05	1.50E-03	4.82E-08	1.30E-03
Eu-152	4.87E+02	3.70E-11	1.00E+01	1.80E-07	4.80E-01	8.65E-08	2.33E-03
Eu154	5.62E+04	3.70E-11	1.00E+01	2.08E-05	3.90E-01	8.11E-06	2.19E-01
Eu-155	1.15E+04	3.70E-11	1.00E+01	4.26E-06	1.60E-02	6.81E-08	1.84E-03
U-234	4.08E+02	3.70E-11	1.00E+01	1.51E-07	6.20E+00	9.36E-07	2.52E-02
U-235	1.60E+01	3.70E-11	1.00E+01	5.92E-09	5.90E+00	3.49E-08	9.41E-04
U-236	6.11E+01	3.70E-11	1.00E+01	2.26E-08	5.80E+00	1.31E-07	3.53E-03
U-238	3.16E+02	3.70E-11	1.00E+01	1.17E-07	5.50E+00	6.43E-07	1.73E-02
Np-237	2.70E+01	3.70E-11	1.00E+01	9.99E-09	2.30E+01	2.30E-07	6.19E-03
Pu-238	5.12E+04	3.70E-11	1.00E+01	1.89E-05	1.50E+01	2.84E-04	7.66E+00
Pu-239	9.93E+04	3.70E-11	1.00E+01	3.67E-05	1.60E+01	5.88E-04	1.58E+01
Pu-240	5.52E+04	3.70E-11	1.00E+01	2.04E-05	1.60E+01	3.27E-04	8.81E+00
Pu-241	3.02E+06	3.70E-11	1.00E+01	1.12E-03	2.60E-01	2.91E-04	7.83E+00
Pu-242	2.42E+01	3.70E-11	1.00E+01	8.95E-09	1.60E+01	1.43E-07	3.86E-03
Am-241	1.67E+05	3.70E-11	1.00E+01	6.18E-05	2.50E+01	1.54E-03	4.16E+01
Am-242	8.16E+01	3.70E-11	1.00E+01	3.02E-08	2.50E-03	7.55E-11	2.03E-06
Am(m)-242	8.20E+01	3.70E-11	1.00E+01	3.03E-08	2.40E+01	7.28E-07	1.96E-02
Am-243	4.89E+01	3.70E-11	1.00E+01	1.81E-08	2.50E+01	4.52E-07	1.22E-02
Cm-242	6.67E+01	3.70E-11	1.00E+01	2.47E-08	8.20E-01	2.02E-08	5.45E-04
Cm-244	5.81E+02	3.70E-11	1.00E+01	2.15E-07	1.30E+01	2.79E-06	7.53E-02
Total	2.77E+07			2.01E+01		3.71E-03	1.00E+02

STACK ASSESSMENT FOR WAC 246-247-075

Facility: 105-KW Basin Discharge Point: IWTS Sparger

Radionuclide	Unabated emissions (Ci/yr)	CAP-88 Dose conversion factor (mrem/Ci)	TEDE to the MEI (mrem/yr)	Dose[a] (percent of total)
Co^{60}	3.74 E-02	4.28 E-02	1.60 E-03	<0.1
Sr^{90} [b]	8.80 E+01	6.45 E-02	5.68 E+00	4.8
Ru^{106}	9.71 E-03	3.08 E-02	2.99 E-04	<0.1
Sb^{125}	3.12 E-01	6.13 E-03	1.91 E-03	<0.1
Cs^{134}	1.74 E-01	4.62 E-02	8.02 E-03	<0.1
Cs^{137} [b]	1.13 E+02	3.53 E-02	3.99 E+00	3.38
Eu^{154}	9.47 E-01	2.69 E-02	2.55 E-02	<0.1
Eu^{155}	1.94 E-01	4.90 E-03	9.50 E-04	<0.1
Pu^{238} [b]	8.63 E-01	1.18 E+01	1.02 E+01	8.62
$Pu^{239/240}$ [b,c]	2.60 E+00	1.28 E+01	3.33 E+01	28.21[c]
Pu^{241} [b]	5.09 E+01	2.03 E-01	1.03 E+01	8.74
Am^{241} [b,c]	2.82 E+00	1.94 E+01	5.46 E+01	46.21[c]
Total	2.60 E+02		1.18 E+02	100.0

[a] Column might not add up to 100% due to rounding off.
[b] Radionuclides that could contribute greater than 0.1 mrem per year PTE TEDE to the MEI.
[c] Radionuclides that could contribute greater than 10% of the potential to emit.

Ci/yr = curie per year.
MEI = maximally exposed individual.
mrem/Ci = millirem per curie.
mrem/yr = millirem per year.
TEDE = total effective dose equivalent.

1706-KE STACK RADIOLOGICAL POTENTIAL-TO-EMIT DOSE DETERMINATION BASED ON RELEASE FRACTIONS FROM WAC 246-247-030(21)(a)

Radionuclide in 105-KW Basin Water Samples	Collection date of 105-KW Basin Water Sample with Highest Radionuclide Concentration[a]	Highest Radionuclide Concentration in 105-KW Basin Water Sample (µCi/mL)[a]	Maximum Radionuclide Inventory Available for 1706-KE Release (Ci/yr)[b]	Release Fraction[c]	CAP-88 Dose-Per-Unit Release Factor (mrem/Ci)[d]	Total Effective Dose to MEI from Potential Radionuclide Emissions (mrem/yr)
^{3}H	3/1/2005	2.2E–03	5.5E–06	1	4.9E–05	2.7E–10
^{90}Sr	7/3/2007	6.2E–03	1.6E–05	1E–03	2.2E–01	3.4E–09
^{137}Cs	4/3/2007	5.2E–03	1.3E–05	1E–03	4.7E–01	6.1E–09
$^{239/240}Pu$	3/6/2007	1.3E–04	3.3E–07	1E–03	1.6E+01	5.2E–09
^{241}Am	3/6/2007	1.2E–04	3.0E–07	1E–03	2.5E+01	7.5E–09
					Total ▶	**2.3E–08**

[a] Determined from analytical results of 105-KW Basin water samples from January 1995 until January 2007.

[b] As of at least 3/26/2008, only samples of 105-KW Basin water were being collected and analyzed, which annually would not exceed 500 individual 5-mL samples, for a total volume of 2,500 mL/yr of basin water as the maximum annual volume subjected to evaporation. The annual Ci values are derived by multiplying each respective concentration by 2,500 mL The procedure conducted in the 1706-KE lab hood and exhausted by the 1706-KE stack currently supports operations at the 105-KW Basin, but in the past both the 105-KW and 105-KE basins. The procedure directs that a heat lamp evaporate a 5-mL sample of basin water on a planchet to leave thin layer of radioactive particles for a gross alpha count.

Table 5. Unabated Dose from the Cold Vacuum Drying Facility. (3 sheets)

Radio-nuclide	Physical Form	Total Unabated Emission (Ci/yr)	Dose Equivalent (mrem/Ci	Total Unabated Dose (mrem/yr)	Fraction of the Unabated Dose
H-3	G (generated)	7.13E-00	2.91E-05	2.08E-04	0.00%
H-3	S (matrixed in fuel)	1.83E-02	2.91E-05	5.32E-07	0.00%
C-14	G (generated)	1.35E-01	1.61E-03	2.17E-04	0.00%
C-14	S (matrixed in fuel)	3.46E-04	1.61E-03	5.57E-07	0.00%
Fe-55	S/P	1.66E-03	3.61E-04	6.01E-07	0.00%
Co-60	S/P	3.58E-03	1.65E-01	5.91E-04	0.00%
Ni-59	S/P	3.71E-05	3.08E-04	1.14E-08	0.00%
Ni-63	S/P	4.06E-03	3.38E-04	1.37E-06	0.00%
Se-79	S/P	7.80E-05	0.00E+01	0.00E+01	0.00%
Kr-85	G (generated)	1.15E+02	6.42E-08	7.38E-06	0.00%
Kr-85	S (matrixed in fuel)	2.95E-01	6.42E-08	1.89E-08	0.00%
Sr-89	S/P	0.00E+01	1.61E-03		0.00%
Sr-90	S/P	9.14E-00	1.11E-01	1.01E-00	8.00%
Y-90	S/P	9.14E-00	2.44E-04	2.23E-03	0.02%
Y-91	S/P	2.02E-20	2.67E-03	5.39E-23	0.00%
Zr-93	S/P	3.62E-04	1.53E-03	5.54E-07	0.00%
Zr-95	S/P	1.53E-18	2.88E-03	4.40E-21	0.00%
Nb-93m	S/P	2.23E-04	3.59E-03	8.02E-07	0.00%
Nb-95	S/P	3.38E-18	3.79E-03	1.28E-20	0.00%
Nb-95m	S/P	1.13E-20	1.29E-04	1.46E-24	0.00%
Tc-99	S/P	2.61E-03	2.34E-02	6.10E-05	0.00%
Ru-103	S/P	0.00E+01	1.39E-03	0.00E+01	0.00%
Ru-106	S/P	1.65E-03	1.80E-02	2.96E-05	0.00%
Rh-103m	S/P	0.00E+01	7.03E-08	0.00E+01	0.00%
Rh-106	S/P	1.65E-03	1.66E-21	2.73E-24	0.00%
Pd-107	S/P	1.47E-05	4.35E-04	6.41E-09	0.00%
Ag-110	S/P	2.57E-10	1.87E-25	4.80E-35	0.00%
Ag-110m	S/P	1.94E-08	3.36E-02	6.50E-10	0.00%
Cd-113m	S/P	3.21E-03	0.00E+01	0.00E+01	0.00%
Cd-115m	S/P	0.00E+01	3.49E-03	0.00E+01	0.00%
In-113m	S/P	1.94E-13	3.07E-06	5.94E-19	0.00%
Sn-113	S/P	1.94E-13	3.41E-03	6.60E-16	0.00%
Sn-119m	S/P	2.69E-07	n/a	0.00E+01	0.00%

Radio-nuclide	Physical Form	Total Unabated Emission (Ci/yr)	Dose Equivalent (mrem/Ci	Total Unabated Dose (mrem/yr)	Fraction of the Unabated Dose
Sn-121m	S/P	7.20E-05	n/a	0.00E+01	0.00%
Sn-123	S/P	1.57E-11	3.19E-05	5.02E-16	0.00%
Sn-126	S/P	1.41E-04	6.11E-02	8.62E-06	0.00%
Sb-124	S/P	2.74E-24	6.21E-03	1.70E-26	0.00%
Sb-125	S/P	3.03E-02	1.66E-02	5.03E-04	0.00%
Sb-126	S/P	1.97E-05	2.21E-03	4.36E-08	0.00%
Sb-126m	S/P	1.41E-04	2.35E-06	3.32E-10	0.00%
Te-123m	S/P	2.50E-17	n/a	0.00E+01	0.00%
Te-125m	S/P	7.40E-03	1.10E-03	8.14E-06	0.00%
Te-127	S/P	8.58E-13	9.61E-06	8.25E-18	0.00%
Te-127m	S/P	8.77E-13	3.19E-03	2.80E-15	0.00%
Te-129	S/P	0.00E+01	1.71E-06	0.00E+01	0.00%
Te-129m	S/P	0.00E+01	2.37E-03	0.00E+01	0.00%
I-129	G (generated)	1.24E-03	2.39E-01	2.97E-04	0.00%
I-129	S (matrixed in fuel)	3.18E-06	2.39E-01	7.61E-07	0.00%
Cs-134	S/P	1.44E-02	9.03E-02	1.30E-03	0.01%
Cs-135	S/P	7.01E-05	6.64E-03	4.66E-07	0.00%
Cs-137	S/P	1.19E+01	1.72E-01	2.05E-00	16.20%
Ba-137m	S/P	1.13E+01	incl. in Cs	0.00E+01	0.00%
Ce-141	S/P	0.00E+01	6.80E-04	0.00E+01	0.00%
Ce-144	S/P	8.27E-04	1.39E-02	1.15E-05	0.00%
Pr-143	S/P	0.00E+01	4.86E-04	0.00E+01	0.00%
Pr-144	S/P	8.17E-04	1.99E-07	1.63E-10	0.00%
Pr-144m	S/P	9.95E-06	1.45E-08	1.44E-13	0.00%
Pm-147	S/P	4.18E-01	1.28E-03	5.35E-04	0.00%
Pm-148	S/P	0.00E+01	5.47E-04	0.00E+01	0.00%
Pm-148m	S/P	0.00E+01	5.97E-03	0.00E+01	0.00%
Sm-151	S/P	1.59E-01	8.78E-04	1.40E-04	0.00%
Eu-152	S/P	8.55E-04	1.58E-01	1.35E-04	0.00%
Eu-154	S/P	9.68E-02	1.28E-01	1.24E-02	0.10%
Eu-155	S/P	2.00E-02	5.66E-03	1.13E-04	0.00%
Gd-153	S/P	1.16E-10	n/a	0.00E+01	0.00%
Tb-160	S/P	2.51E-21	4.81E-03	1.21E-23	0.00%
U-234	S/P	7.91E-04	3.56E-00	2.81E-03	0.02%
U-235	S/P	3.05E-05	3.37E-00	1.03E-04	0.00%
U-236	S/P	1.15E-04	3.37E-00	3.87E-04	0.00%

Radio-nuclide	Physical Form	Total Unabated Emission (Ci/yr)	Dose Equivalent (mrem/Ci	Total Unabated Dose (mrem/yr)	Fraction of the Unabated Dose
U-238	S/P	6.30E-04	3.17E-00	2.00E-03	0.02%
Np-237	S/P	5.17E-05	1.33E+01	6.88E-04	0.01%
Pu-238	S/P	1.00E-01	8.75E-00	8.79E-01	6.93%
Pu-239	S/P	1.97E-01	9.44E-00	1.86E-00	14.69%
Pu-240	S/P	1.08E-01	9.43E-00	1.02E-00	8.01%
Pu-241	S/P	6.04E-00	1.48E-01	8.94E-01	7.06%
Pu-242	S/P	4.97E-05	8.97E-00	4.45E-04	0.00%
Am-241	S/P	3.39E-01	1.45E+01	4.92E-00	38.80%
Am-242	S/P	1.76E-04	1.40E-03	2.47E-07	0.00%
Am-242m	S/P	1.77E-04	1.40E+01	2.48E-03	0.02%
Am-243	S/P	1.09E-04	1.45E+01	1.57E-03	0.01%
Cm-242	S/P	1.47E-04	4.72E-01	6.92E-05	0.00%
Cm-244	S/P	1.30E-03	7.67E-00	9.99E-03	0.08%
Totals				1.27E+01	100.00%

Notes:

1. Dose factors are calculated for the 100 Area using CAP 88PC (Staven 1998 – see Appendix C)
2. The dose factor for Cs-137 accounts for the dose from all daughter-product decay reactions.
3. The Pu-239 dose factor is used because Pu-239 and Pu-240 are reported together in laboratory analyses.
4. G - gas, S - solid, P - particulate matter.

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A2 200 EAST AREA

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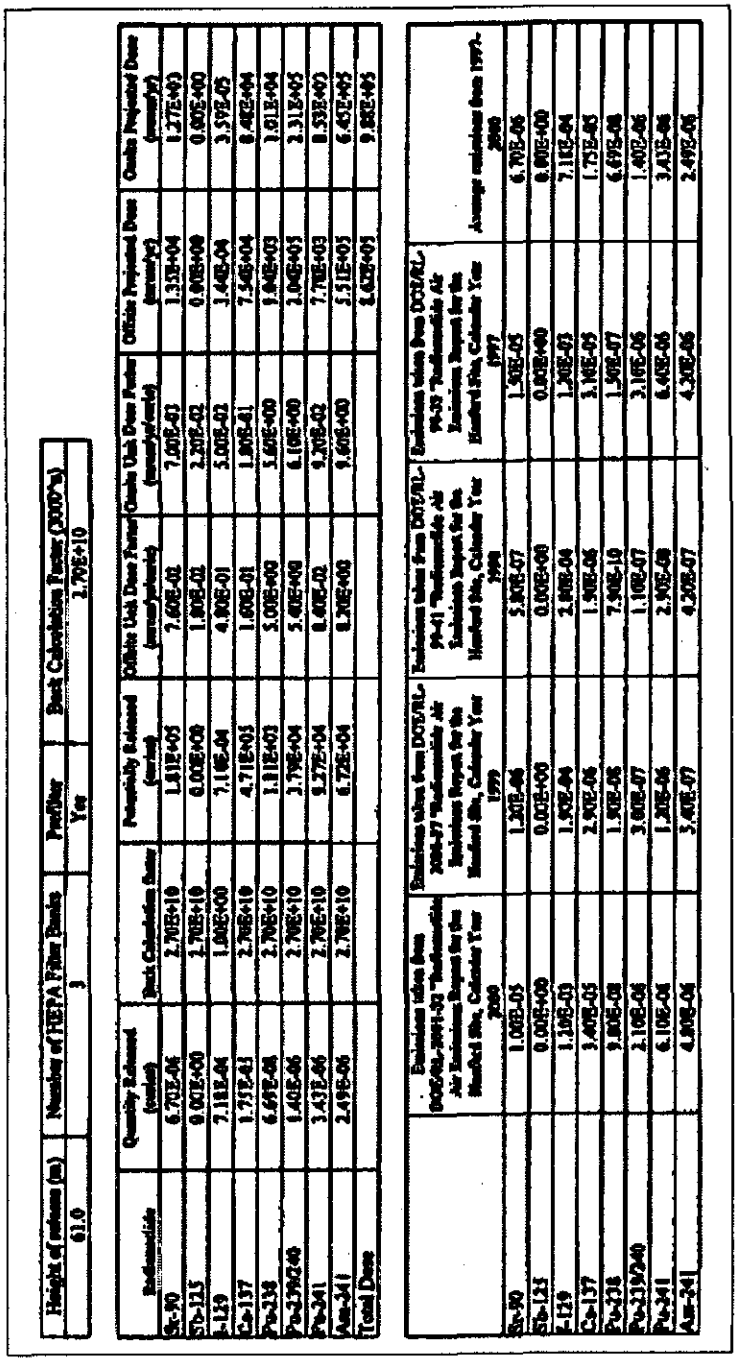
STACK ASSESSMENT FOR WAC 246-247-075
RELEASE FACTORS FROM WAC 246-247-030(21)(a) SOURCE ASSESSMENT

Facility: PUREX

Discharge Point: 291-A-1



Height of release (m)	Number of HEPA Filter Banks	Pre-Filter	Stack Calculation Factor (2000's)
61.0	3	Yes	1.70E+10

Radionuclide	Quantity Released (curies)	Stack Calculation Factor	Potentially Released (curies)	Offsite Unit Dose Factor (mrem/yr/curie)	Onsite Unit Dose Factor (mrem/yr/curie)	Offsite Projected Dose (mrem/yr)	Onsite Projected Dose (mrem/yr)
Sr-90	6.70E-06	2.70E+10	1.81E+05	7.40E-02	7.00E-01	1.33E+04	1.27E+05
Sb-125	0.00E+00	2.70E+10	0.00E+00	1.80E-02	2.20E-02	0.00E+00	0.00E+00
I-129	7.11E-04	1.00E+00	7.11E-04	4.80E-01	5.00E-02	3.41E-04	3.59E-05
Cs-137	1.71E-01	2.70E+10	4.71E+03	1.60E-01	1.80E-01	7.54E+04	8.48E+04
Pu-238	6.69E-06	2.70E+10	1.81E+03	5.00E+00	5.60E+00	1.84E+03	1.91E+04
Pu-239/240	1.40E-06	2.70E+10	3.78E+04	5.40E+00	6.10E+00	2.04E+03	2.31E+05
Pu-241	3.43E-04	2.70E+10	9.27E+04	8.40E-02	9.20E-02	7.70E+03	8.53E+03
Am-241	2.49E-06	2.70E+10	6.72E+04	8.20E+00	9.60E+00	5.51E+05	6.45E+05
Total Dose						8.42E+05	9.86E+05

	Emissions taken from DOE/RL-2006-97 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1999"	Emissions taken from DOE/RL-94-41 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1998"	Emissions taken from DOE/RL-91-39 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1997"	Average emissions from 1997-2000
Sr-90	1.00E-05	1.20E-06	5.80E-07	1.90E-05	6.70E-06
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	1.16E-03	1.90E-04	2.80E-04	1.20E-03	7.11E-04
Cs-137	3.40E-05	2.90E-06	1.90E-06	3.10E-05	1.75E-05
Pu-238	9.80E-08	1.90E-05	7.90E-10	1.90E-07	6.69E-06
Pu-239/240	2.10E-06	3.80E-07	1.10E-07	3.10E-06	1.40E-06
Pu-241	6.10E-04	1.20E-06	2.90E-08	6.40E-06	3.43E-04
Am-241	4.80E-06	3.40E-07	4.20E-07	4.20E-06	2.49E-06

STACK ASSESSMENT FOR WAC 246-247-075
RELEASE FACTORS FROM WAC 246-247-030(21)(a) SOURCE ASSESSMENT

Facility: PUREX Discharge Point: 291-A-10

Radionuclide	Annual PTE (Ci/yr)	Release Factor	CAP88-PC (mrem/Ci)	Unabated Offsite Dose (mrem/yr)	Abated Offsite Dose (mrem/yr)
1. Storage of Existing Tunnel Inventory (based on total NDA loading on HEPA filters, decay-corrected and annualized)					
^{90}Sr (calculated from NDA)	3.9E–05	1.0E+00	1.1E–01	4.3E–06	2.1E–09
^{137}Cs (measured by NDA)	2.3E–05	1.0E+00	2.7E–02	6.2E–07	3.1E–10
^{239}Pu (calculated from NDA)	2.5E–06	1.0E+00	8.2E+00	2.1E–05	1.0E–08
^{241}Am (calculated from NDA)	6.0E–06	1.0E+00	1.3E+01	7.8E–05	3.9E–08
Baseline emissions				1.0E–04	5.2E–08
2. Transfers at PUREX Rail Cut (based on release factor for concrete burial box in previous NOC, for 1 yr duration)					
Total β-γ (as ^{90}Sr)	3.5E+06	6.6E–08	1.1E–01	2.5E–02	8.4E–06
Total α (as ^{241}Am)	3.5E+04	6.6E–08	1.3E+01	3.0E–02	1.0E–05
Subtotal				5.5E–02	1.8E–05
3. Insertion of Rail Cars into PUREX Tunnel (based on increased NDA loading on HEPA filters, for 7 rail cars placed in tunnel in 1996					
^{90}Sr (calculated from NDA)	5.9E–05	1.0E+00	1.1E–01	6.5E–06	3.2E–09
^{137}Cs (measured by NDA)	3.5E–05	1.0E+00	2.7E–02	9.5E–07	4.7E–10
^{239}Pu (calculated from NDA)	3.9E–06	1.0E+00	8.2E+00	3.2E–05	1.6E–08
^{241}Am (calculated from NDA)	9.1E–06	1.0E+00	1.38E+01	1.2E–04	5.9E–08
Subtotal (for 7 rail cars)				1.6E–04	7.9E–08
Subtotal (for 12 rail cars)				3.2E–04	1.6E–07
4. Storage of Proposed Additional Tunnel Inventory (based on ratio with 0.96 MCi baseline)					
Additional 3.5 MCi				3.6E–04	1.8E–07
Totals	**Total modifications increase (§§2, 3, & 4)**			**5.6E–02**	**1.9E–05**
	Total stack potential dose (§§1, 3, & 4)			7.8E–04	3.9E–07

STACK ASSESSMENT FOR WAC 246-247-075
RELEASE FACTORS FROM WAC 246-247-030(21)(a) SOURCE ASSESSMENT

Facility: B Plant Discharge Point: 291-B-1

Radionuclides	Total Unabated Release (Ci)	Total Abated Emissions (Ci)	Total Unabated Offsite Dose (mrem/yr)	Total Abated offsite Dose (mrem/yr)	Percent of Offsite Dose
^{90}Sr	1.45E+02	5.09E–01	6.36E+00	2.23E–02	49.2914
^{90}Y	1.45E+02	5.09E–01	5.48E–02	1.92E–04	0.4243
^{125}Sb	1.64E–01	4.10E–08	6.81E–04	1.70E–10	0
^{137}Cs	1.48E+03	9.50E–01	3.53E+01	2.27E–02	50.2400
^{238}Pu	3.60E–02	9.00E–09	2.89E–01	7.22E–08	0.0002
$^{239/240}Pu$	3.84E+00	2.21E–06	3.33E+01	1.91E–05	0.0424
^{241}Am	2.56E–01	6.40E–08	3.35E+00	8.38E–07	0.0019
Total	**1.77E+03**	**1.97E+00**	**7.87E+01**	**4.52E–02**	**100**

STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
RELEASE FACTORS FROM APPENDIX D SOURCE ASSESSMENT

Facility: WESF

Discharge Point: 296-B-10

Height of Release (m)	HEPA filters	Prefilter
2.29E+01	2	Yes

Location of contamination	Isotope	Quantity (curies)	Release Factor	Potential Release (curies)	Offsite Unit Dose Factor (<40 m)	Onsite Unit Dose Factor (<40 m)	Offsite Dose (<40m) (mrem/yr)	Onsite Dose (<40m) (mrem/yr)
Duct								
	Sr-90	3.00E+04	1.00E-06	3.00E-02	1.10E-01	9.50E-03	3.30E-03	2.85E-04
	Cs-137	4.34E+03	1.00E-06	4.34E-03	2.40E-01	2.70E-01	1.04E-03	1.17E-03
A CELL	Sr-90	5.71E+02	1.00E-03	5.71E-01	1.10E-01	9.50E-03	6.28E-02	5.42E-03
	Cs-137	8.30E+01	1.00E-03	8.30E-02	2.40E-01	2.70E-01	1.99E-02	2.24E-02
B CELL	Sr-90	1.65E+04	1.00E-03	2.48E+01	1.10E-01	9.50E-03	2.73E+00	2.36E-01
	Cs-137	4.10E+03	1.00E-03	3.30E+00	2.40E-01	2.70E-01	7.92E-01	8.91E-01
C CELL	Sr-90	1.65E+04	1.00E-03	1.65E+01	1.10E-01	9.50E-03	1.82E+00	1.57E-01
	Cs-137	4.10E+03	1.00E-03	3.30E+00	2.40E-01	2.70E-01	7.92E-01	8.91E-01
D& E CELL	Sr-90	4.20E+03	1.00E-03	4.20E+00	1.10E-01	9.50E-03	4.62E-01	3.99E-02
	Cs-137	6.00E+04	1.00E-03	6.00E+01	2.40E-01	2.70E-01	1.44E+01	1.62E+01
F CELL	Sr-90	8.30E+01	1.00E-03	8.30E-02	1.10E-01	9.50E-03	9.13E-03	7.89E-04
	Cs-137	8.30E+01	1.00E-03	8.30E-02	2.40E-01	2.70E-01	1.99E-02	2.24E-02
G CELL	Sr-90	1.00E+00	1.00E-03	1.00E-03	1.10E-01	9.50E-03	1.10E-04	9.50E-06
	Cs-137	1.00E+00	1.00E-03	1.00E-03	2.40E-01	2.70E-01	2.40E-04	2.70E-04
	1 was used as default for G Cell							
Total Dose (mrem/yr)							2.11E+01	1.85E+01

Table 11-2. Canister Storage Building Potential Unabated Onsite Dose Using CAP88 PC Version. (2 sheets)

Radionuclide	Unabated emissions (Ci/year)	Dose equivalent (CSB area) (mrem/Ci)	Total dose unabated (mrem/yr)	Percent of total unabated dose*
^{3}H	3.65 E-02	4.16 E-06	1.51 E-07	0
^{3}H	4.58 E+01	4.16 E-06	1.90 E-04	0
^{14}C	8.66 E-01	1.11 E-04	9.65 E-05	0
^{14}C	6.90 E-04	1.11 E-04	7.69 E-08	0
^{55}Fe	1.83 E-03	4.05 E-05	7.41 E-08	0
^{60}Co	1.98 E-02	2.03 E-01	4.02 E-03	0
^{59}Ni	2.05 E-04	1.93 E-04	3.95 E-08	0
^{63}Ni	2.24 E-02	4.50 E-05	1.01 E-06	0
^{79}Se (^{241}Pu)	4.31 E-04	9.24 E-02	3.98 E-05	0
^{85}Kr	7.38 E+02	3.81 E-08	2.81 E-05	0
^{85}Kr	5.88 E-01	3.81 E-08	2.24 E-08	0
^{89}Sr	0.00 E+00	1.43 E-04	0.00 E+00	0
^{90}Sr	5.05 E+01	7.00 E-03	3.53 E-01	0
^{90}Y	5.05 E+01	1.64 E-04	8.28 E-03	0
^{91}Y	1.11 E-19	8.98 E-04	1.00 E-22	0
^{93}Zr	2.00 E-03	8.57 E-04	1.71 E-06	0
^{95}Zr	8.44 E-18	2.76 E-03	2.33 E-20	0
^{93m}Nb	1.23 E-03	7.81 E-04	9.64 E-07	0
^{95}Nb	1.87 E-17	1.66 E-03	3.09 E-20	0
^{95m}Nb	6.25 E-20	6.50 E-05	4.06 E-24	0
^{99}Tc	1.44 E-02	2.81 E-03	4.05 E-05	0
^{103}Ru	0.00 E+00	4.77 E-05	0.00 E+00	0
^{106}Ru	9.09 E-03	2.22 E-05	2.02 E-07	0
^{103m}Rh	0.00 E+00	6.38 E-08	0.00 E+00	0
^{106}Rh	9.09 E-03	0.00 E+00	0.00 E+00	0
^{107}Pd	8.14 E-05	0.00 E+00	0.00 E+00	0
^{110}Ag	1.42 E-09	1.48 E-29	2.10 E-38	0
^{110m}Ag	1.07 E-07	0.00 E+00	0.00 E+00	0
^{113m}Cd (^{241}Pu)	1.77 E-02	9.24 E-02	1.64 E-03	0
^{115m}Cd	0.00 E+00	1.08 E-04	0.00 E+00	0
^{113m}In	1.07 E-12	8.62 E-04	9.21 E-16	0
^{113}Sn	1.07 E-12	5.16 E-06	5.52 E-18	0
^{119m}Sn (^{239}Pu)	1.48 E-06	6.07 E+00	9.00 E-06	0
^{121m}Sn (^{239}Pu)	3.98 E-04	6.07 E+00	2.41 E-03	0
^{123}Sn	8.69 E-11	3.67 E-04	3.19 E-14	0
^{126}Sn	7.79 E-04	4.62 E-04	3.60 E-07	0
^{124}Sb	1.51 E-23	2.76 E-02	4.17 E-25	0
^{125}Sb	1.67 E-01	6.03 E-03	1.01 E-03	0
^{126}Sb	1.09 E-04	2.19 E-02	2.39 E-06	0
^{126m}Sb	7.79 E-04	2.08 E-03	1.62 E-06	0
^{123m}Te (^{239}Pu)	1.38 E-16	6.07 E+00	8.37 E-16	0
^{125m}Te	4.09 E-02	2.55 E-04	1.04 E-05	0
^{127}Te	4.74 E-12	2.12 E-04	1.01 E-15	0
^{127m}Te	4.84 E-12	6.97 E-06	3.37 E-17	0

Radionuclide	Unabated emissions (Ci/year)	Dose equivalent (CSB area) (mrem/Ci)	Total dose unabated (mrem/yr)	Percent of total unabated dose*
^{129}Te	0.00 E+00	4.73 E-04	0.00 E+00	0
^{129m}Te	0.00 E+00	1.50 E-06	0.00 E+00	0
^{129}I	7.96 E-03	8.12 E-04	6.46 E-06	0
^{129}I	6.34 E-06	8.12 E-04	5.15 E-09	0
^{134}Cs	7.94 E-02	7.59 E-07	6.03 E-08	0
^{135}Cs	3.87 E-04	8.76 E-07	3.39 E-10	0
^{137}Cs	6.59 E+01	1.68 E-03	1.11 E-01	0
^{137m}Ba	6.25 E+01	1.61 E-03	1.01 E-01	0
^{141}Ce	0.00 E+00	2.34 E-05	0.00 E+00	0
^{144}Ce	4.57 E-03	8.62 E-05	3.94 E-07	0
^{143}Pr	0.00 E+00	7.01 E-03	0.00 E+00	0
^{144}Pr	4.51 E-03	1.53 E-04	6.90 E-07	0
^{144m}Pr	5.50 E-05	1.59 E-07	8.74 E-12	0
^{147}Pm	2.31 E+00	2.11 E-04	4.87 E-04	0
^{148}Pm	0.00 E+00	6.94 E-04	0.00 E+00	0
^{148m}Pm	0.00 E+00	3.63 E-04	0.00 E+00	0
^{151}Sm	8.79 E-01	1.33 E+00	1.17 E+00	0
^{152}Eu	4.72 E-03	4.59 E-05	2.17 E-07	0
^{154}Eu	5.35 E-01	8.74 E-06	4.67 E-06	0
^{155}Eu	1.10 E-01	1.66 E-01	1.83 E-02	0
^{153}Gd (^{239}Pu)	6.39 E-10	6.07 E+00	3.88 E-09	0
^{160}Tb	1.38 E-20	4.45 E-03	6.16 E-23	0
^{234}U	4.37 E-03	8.73 E+00	3.81 E-02	0
^{235}U	1.68 E-04	6.24 E-04	1.05 E-07	0
^{236}U	6.34 E-04	7.17 E-05	4.55 E-08	0
^{238}U	3.48 E-03	2.24 E-08	7.79 E-11	0
^{237}Np	2.86 E-04	5.10 E+00	1.46 E-03	0
^{238}Pu	5.55 E-01	5.65 E+00	3.13 E+00	8.61 E+00
^{239}Pu	1.09 E+00	6.07 E+00	6.61 E+00	1.82 E+01
^{240}Pu	5.95 E-01	6.06 E+00	3.60 E+00	9.90 E+00
^{241}Pu	3.34 E+01	9.24 E-02	3.08 E+00	8.48 E+00
^{242}Pu	2.74 E-04	5.77 E+00	1.58 E-03	0
^{241}Am	1.87 E+00	9.65 E+00	1.81 E+01	4.97 E+01
^{242}Am	9.74 E-04	1.00 E-03	9.74 E-07	0
^{242m}Am	9.79 E-04	9.29 E+00	9.09 E-03	0
^{243}Am	6.00 E-04	9.65 E+00	5.78 E-03	0
^{242}Cm	8.09 E-04	3.18 E-01	2.58 E-04	0
^{244}Cm	7.19 E-03	5.10 E+00	3.67 E-02	0
Total			3.64 E+01	

*Values less than 1% are listed as "0."

CSB = Canister Storage Building.

STACK ASSESSMENT FOR WAC 246-247-075
RELEASE FACTORS FROM WAC 246-247-030(21)(a) SOURCE ASSESSMENT

Facility: ETF Discharge Point: 296-E-1

Source	Radionuclide Contributor	Potential-to-Emit (Unabated) TEDE to the MEI (Ci/yr)		Abated TEDE to the MEI (Ci/yr)	
		Offsite	Onsite	Offsite	Onsite
ETF stack	Total alpha	2.45E–03	2.83E–03	1.23E-06	1.41E-06
	Total beta	3.65E–02	1.47E–02	1.82E–05	7.34E–06
	Total	3.89E–02	1.75E–02	1.95E–05	8.75E–06
LERF/ETF diffuse and fugitive emissions	Total alpha	2.89E–03	3.33E–03	N/A	
	Total beta	4.30E–02	1.73E–02		
	Total	4.59E–02	2.06E–02		

STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
(RELEASE FACTORS FROM WAC 246-247-030(21)(a) SOURCE ASSESSMENT)

Facility: **209-E**
Release height (ft/m): 32/9.75
Prefilter: Yes

Discharge Point: **296-P-31**
HEPA filter banks (n): 2
Release fraction: **1.00E-3**[3]

Radionuclide	Quantity in Inventory (g)[1]	Conversion (Ci/g)[2]	Quantity in Inventory (Ci)	Potential Quantity Released (Ci)[3]	Offsite Dose-per-Unit Release Factor (<40 m) (mrem/yr/Ci)[4]	Onsite Dose-per-Unit Release Factor (<40 m) (mrem/yr/Ci)[4]	Offsite Projected Dose (<40 m) (mrem/yr)	Onsite Projected Dose (<40 m) (mrem/yr)
Pu-238	5.24E-01	1.71E+01	8.96E+00	8.96E-03	7.60E+00	8.90E+00	6.81E-02	7.97E-02
Pu-239	4.35E+02	8.22E-02	2.71E+01	2.71E-02	8.20E+00	9.50E+00	2.22E-01	2.57E-01
Pu-240	6.48E+01	2.28E-01	1.48E+01	1.48E-02	8.20E+00	9.50E+00	1.21E-01	1.40E-01
Pu-241	3.03E+00	1.03E+02	3.12E+02	3.12E-01	1.30E-01	1.50E-01	4.06E-02	4.68E-02
Pu-242	1.33E+00	3.93E-03	5.23E-03	5.23E-06	7.80E+00	9.10E+00	4.08E-05	4.76E-05
Am-241	1.38E+01	3.43E+00	4.73E+01	4.73E-02	1.30E+01	1.50E+01	6.15E-01	7.10E-01
Total Potential-to-Emit (mrem/yr)							1.07E+00	1.23E+00

[1] Quantity obtained from CP-15584, rev 2, *Documented Safety Analysis for 209-E Facility Critical Mass Laboratory*, September 29, 2006, p 3-4, Table 3-6, 209-E "Normal Facility Inventory", last column, ;Total Facility Nominal (g)".

[2] LA-12981, *Table of DOE-STD-1027-29, Hazard Category 3 Threshold Quantities for the ICRP-30 List of 757 Radionuclides*, Aug 1995, p 24.

[3] Calculated using the release fraction 1.0E-3, WAC 246-247-030(21)(a)(ii).

[4] DOE/RL-2006-29, rev 0, *Calculating Potential-to-Emit Radiological Releases and Doses*, May 11, 2006, page 4-39, Table 4-9.
CAP88-PC unit dose factors for MPR (200E, stack <40m)

A3 200 WEST AREA

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Table 3. Potential Releases/Doses through the 291-Z-1 Stack during PFP Deactivation.[a]

Isotopes	Curies	Release fraction	Unabated release (curies)	Total abated release (curies)[b]	Dose-per unit release factor (millirem per curie)[c]	Unabated dose (millirem per year)	Abated dose (millirem per year)
Pu-238	5,946	1 E-03	6.0 E+00	3.0 E-04	6.5 E+00	3.9 E+01	2.0 E-03
Pu-239	9,012	1 E-03	9.0 E+00	4.5 E-04	7.0 E+00	6.3 E+01	3.2 E-03
Pu-240	6,015	1 E-03	6.0 E+00	3.0 E-04	7.0 E+00	4.2 E+01	2.1 E-03
Pu-241	174,100	1 E-03	1.7 E+02	8.5 E-03	1.1 E-01	1.9 E+01	9.4 E-04
Pu-242	2.6	1 E-03	2.6 E-03	1.3 E-07	6.7 E+00	1.7 E-02	8.7 E-07
Am-241	17,421	1 E-03	1.7 E+01	8.5 E-04	1.1 E+01	1.9 E+02	9.4 E-03
U-233	14.4	1 E-03	1.4 E-02	7.0 E-07	2.8 E+00	3.9 E-02	2.0 E-06
U-234	0.2	1 E-03	2.0 E-04	1.0 E-08	2.7 E+00	5.4 E-04	2.7 E-08
U-235	0.0038	1 E-03	3.8 E-06	1.9 E-10	2.6 E+00	9.9 E-06	4.9 E-10
U-236	0.002	1 E-03	2.0 E-06	1.0 E-10	2.6 E+00	5.2 E-06	2.6 E-10
U-237	3.6	1 E-03	3.6 E-03	1.8 E-07	1.4 E-04	5.0 E-07	2.5 E-11
U-238	0.027	1 E-03	2.7 E-05	1.4 E-09	2.4 E+00	6.5 E-05	3.4 E-09
Np-237	0.05	1 E-03	5.0 E-05	2.5 E-09	1.0 E+01	5.0 E-04	2.5 E-08
Total	**212,500**		**213**	**1.0 E-02**		**350**	**1.8 E-02**

[a] Hold-up material and fuel handling.

[b] Credit for one stage of testable HEPA filtration. An additional factor of 10 was applied to account for existing HEPA-type filtration associated with the process gloveboxes and packaging of material removed from process areas.

[c] HNF-3602, Rev. 1; 200 West Area, onsite MPR, effective release height $\geq$40 meters.

Table 4. Dose Estimates for the 296-Z-5 Stack.

Radionuclide	Inventory (curies)	Release factor	Unabated release (Ci)	Unit dose factor[a]	Unabated TEDE to the MEI (millirem per year)	Abated TEDE to the MEI[b] (millirem per year)
alpha (as Pu-239)	5	10^{-3}	5×10^{-3}	11	5.5×10^{-2}	2.8×10^{-5}
beta (as Sr-90)	1.2×10^{-4}	10^{-3}	1.2×10^{-7}	1.1×10^{-2}	1.3×10^{-9}	6.5×10^{-13}
Total					**5.5×10^{-2}**	**2.8×10^{-5}**

[a] HNF-3602, Revision 1, *Calculating Potential-to-Emit Releases and Doses for FEMPs and NOCs*, Table 4-10, effective release height <40 meters, onsite MPR.
[b] Credit for one-stage of HEPA filtration (decontamination factor of 5×10^{-4}).

Table 5. Dose Estimates for the 296-Z-6 Stack.

Radionuclide	Inventory (curies)	Release factor	Unabated release (Ci)	Unit dose factor[a]	Unabated TEDE to the MEI (millirem per year)	Abated TEDE to the MEI[b] (millirem per year)
alpha (as Pu-239)	5	10^{-3}	5×10^{-3}	11	5.5×10^{-2}	2.8×10^{-5}
beta (as Sr-90)	1.2×10^{-4}	10^{-3}	1.2×10^{-7}	1.1×10^{-2}	1.3×10^{-9}	6.5×10^{-13}
Total					**5.5×10^{-2}**	**2.8×10^{-5}**

[a] HNF-3602, Revision 1, *Calculating Potential-to-Emit Releases and Doses for FEMPs and NOCs*, Table 4-10, effective release height <40 meters, onsite MPR.
[b] Credit for one-stage of HEPA filtration (decontamination factor of 5×10^{-4}).

Table 6. Potential Releases/Doses through the 296-Z-7 Stack during PFP Deactivation.[a]

Isotope	Curies	Release fraction	Unabated release (curies)	Abated release (curies) 2 HEPA (2.7 E-07)	Dose-per unit release factor (millirem per curie)[b]	Unabated dose (millirem per year)	Abated dose (millirem per year)
Pu-238	5,946	1 E-03	6.0 E+00	1.6 E-06	1.0 E+01	6.0 E+01	1.6 E-05
Pu-239	9,012	1 E-03	9.0 E+00	2.4 E-06	1.1 E+01	9.9 E+01	2.6 E-05
Pu-240	6,015	1 E-03	6.0 E+00	1.6 E-06	1.1 E+01	6.6 E+01	1.8 E-05
Pu-241	174,100	1 E-03	1.7 E+02	4.7 E-05	1.6 E-01	2.7 E+01	7.5 E-06
Pu-242	2.6	1 E-03	2.6 E-03	7.0 E-10	1.0 E+01	2.6 E-02	7.0 E-09
Am-241	17,421	1 E-03	1.7 E+01	4.7 E-06	1.7 E+01	2.9 E+02	8.0 E-05
U-233	14.4	1 E-03	1.4 E-02	3.8 E-09	4.2 E+00	5.9 E-02	1.6 E-08
U-234	0.2	1 E-03	2.0 E-04	5.4 E-11	4.2 E+00	8.4 E-04	2.3 E-10
U-235	0.0038	1 E-03	3.8 E-06	1.0 E-12	4.0 E+00	1.5 E-05	4.0 E-12
U-236	0.002	1 E-03	2.0 E-06	5.4 E-13	3.9 E+00	7.8 E-06	2.1 E-12
U-237	3.6	1 E-03	3.6 E-03	9.7 E-10	2.1 E-04	7.6 E-07	2.0 E-13
U-238	0.027	1 E-03	2.7 E-05	7.3 E-12	3.7 E+00	1.0 E-04	2.7 E-11
Np-237	0.05	1 E-03	5.0 E-05	1.4 E-11	1.6 E+01	8.0 E-04	2.2 E-10
Total	**212,500**		**213**	**5.7 E-05**		**542**	**1.5 E-04**

[a] Hold-up material plus fuel handling.

[b] HNF-3602, Rev. 1; 200 West Area, onsite MPR, effective release height <40 meters.

HEPA = high-efficiency particulate air.

MPR = maximum public receptor.

Table B. Potential Releases/Doses through the 296-Z-15 Stack during PFP Deactivation*.

Isotope	Curies	Release Fraction	Total Unabated Release (curies)	Total Abated Release (curies) 1-HEPA (5 E-04)	Dose-per Unit Release Factor (mrem/Ci)**	Unabated Dose (mrem per year)	Abated Dose (mrem per year)
Pu-238	0.85	1 E-03	8.5 E-04	4.3 E-07	1.0 E+01	8.5 E-03	4.3 E-06
Pu-239	1.3	1 E-03	1.3 E-03	6.5 E-07	1.1 E+01	1.4 E-02	7.1 E-06
Pu-240	0.88	1 E-03	8.8 E-04	4.4 E-07	1.1 E+01	9.7 E-03	4.8 E-06
Pu-241	25	1 E-03	2.5 E-02	1.3 E-05	1.6 E-01	4.0 E-03	2.1 E-06
Pu-242	5.0 E-04	1 E-03	5.0 E-07	2.5 E-10	1.0 E+01	5.0 E-06	2.5 E-09
Am-241	2.5	1 E-03	2.5 E-03	1.3 E-06	1.7 E+01	4.3 E-02	2.2 E-05
U-233	0.0024	1 E-03	2.4 E-06	1.2 E-09	4.2 E+00	1.0 E-05	5.0 E-09
U-234	2.5 E-05	1 E-03	2.5 E-08	1.3 E-11	4.2 E+00	1.1 E-07	5.5 E-11
U-235	2.5 E-08	1 E-03	2.5 E-11	1.3 E-14	4.0 E+00	1.0 E-10	5.2 E-14
U-236	2.5 E-07	1 E-03	2.5 E-10	1.3 E-13	3.9 E+00	9.8 E-10	5.1 E-13
U-237	5.0 E-04	1 E-03	5.0 E-07	2.5 E-10	2.1 E-04	1.1 E-10	5.3 E-14
U-238	5.0 E-13	1 E-03	5.0 E-16	2.5 E-19	3.7 E+00	1.9 E-15	9.3 E-19
Np-237	7.5 E-06	1 E-03	7.5 E-09	3.8 E-12	1.6 E+01	1.2 E-07	6.1 E-11
Total	30.5		3.1 E-02	1.5 E-05		0.079	3.9 E-05

*Residual activity plus waste packaging.

**HNF-3602, Revision 1; 200-W Area, Onsite MPR, effective release height < 40 meters.

STACK ASSESSMENT FOR 40 CFR 61 SUBPART H

Facility: REDOX
Release height (ft/m): 200/60.96
Prefilter: None
Discharge point: 291-S-1
Filter: Sand
Back calculation factor: 500[a]

Radionuclide	Quantity Released (Ci)[b]	Potential Quantity Released (Ci)	Unit Release Factor (>40 m) (mrem/yr/Ci)[c]	Unit Release Factor (>40 m) (mrem/yr/Ci)[c]	Offsite Projected Dose (>40 m) (mrem/yr)	Onsite Projected Dose (>40 m) (mrem/yr)
Total α (as ^{241}Am)[d]	4.70E–07	2.35E–04	7.2E+00	1.10E+01	1.69E–03	2.59E–03
Total β (as ^{137}Cs+D)[d]	6.00E–06	3.00E–03	1.50E–01	2.10E–01	4.5E–04	6.30E–04
				Total dose (mrem/yr) ▶	2.14E–03	3.22E–03

[a] Collection efficiency reported as 99.5 percent in ANL-7683, "Sand-Bed Filtration of Aerosols: A Review of Published Information on their Use in Industrial and Atomic Energy Facilities," Argonne National Laboratory, June 1970, pp. 36 & 40. The treatment factor for sand filters is reported as the inverse of 1–0.998 (i.e., 500) in WHC-EP-0498, "Unit Dose Calculation Methods and Summary of Facility Effluent Monitoring Plan Determinations," November 1991, pp. 4–5.

[b] Quantity released obtained as maximum emission (Ci/yr) from annual reports, 1997-2006 (10 yrs—see below for emission results for the past 10 years).

[c] DOE/RL-2006-29, Rev. 0, "Calculating Potential-to-Emit Radiological Releases and Doses," May 11, 2006, Table 4-10, pp. 4-43 & 4-46

[d] ^{241}Am and ^{137}Cs+D were used as conservative estimates of total α and β respectively. The nuclide plus daughter was used for ^{137}Cs. "Plus daughter" indicates that factors from in-growth are also included; again, a conservative estimate.

	Quantity Release Data (Ci)									
	2006[a]	2005[b]	2004[c]	2003[d]	2002[e]	2001[f]	2000[g]	1999[h]	1998[i]	1997[j]
Emissions (total α)[k]	3.4E–07	1.8E–07	ND	2.6E–07	ND	8.3E–08	ND	2.1E–07	4.7E–07	ND
Emissions (total β)[k]	7.8E–07	8.2E–07	4.4E–07	5.8E–07	ND	1.2E–06	8.7E–07	3.9E–06	6.0E–06	4.8E–06

[a] DOE/RL-2007-01, p. 2-9 [b] DOE/RL-2006-01, p. 2-8 [c] DOE/RL-2005-06, p. 2-8 [d] DOE/RL-2004-09, p. 2-8
[e] DOE/RL-2003-19, p. 2-9 [f] DOE/RL-2002-20, p. 2-12 [g] DOE/RL-2001-32, p. 2-12 [h] DOE/RL-2000-37, p. 2-14
[i] DOE/RL-99-41, p. 2-12 [j] DOE/RL-98-33, p. 2-11 [k] ND = not detectable

STACK 291-T-1

Table B-2. T Plant Operations (Excluding Sludge and Fuel).

Isotope	Potential unabated release (Ci/yr)	Potential abated release (Ci/yr)	Dose factor CAP88-PC* (mrem/Ci)	Unabated offsite dose (mrem/yr)	Abated offsite dose (mrem/yr)
Sr-90	1.94E+01	9.7E-03	8.7E-03	1.7E-01	8.4E-05
Cs-137	1.46E+01	7.3E-04	2.1E-01	3.1E+00	1.5E-04
Pu-239/240	1.38E+01	6.9E-03	7.0E+00	9.7E+01	4.8E-02
Am-241	1.38E+00	6.9E-04	1.1E+01	1.5E+01	7.6E-03
Total PTE				1.2E+02	5.6E-02

STACK 291-T-7

Activity	PTE (mrem/yr) 200 ADF	PTE (mrem/yr) Stack
Storing TRU	3.2E–04	3.2E–04
Venting TRU	—	9.2E–03
Gas (cutting)	—	9.0E–04
Gas (other)	—	7.0E–04
Contamination	7.1E–03	7.1E–03
Other stack-on activities	—	4.9E–02
Total		7.5E–02

STACK ASSESSMENT FOR 40 CFR 61 SUBPART H

Facility: U Plant
Release height (ft/m): 200/60.96
Prefilter: None
Discharge point: 291-U-1
Filter: Sand
Back calculation factor: 500[a]

Radionuclide	Quantity Released (Ci)[b]	Potential Quantity Released (Ci)	Unit Release Factor (>40 m) (mrem/yr/Ci)[c]	Unit Release Factor (>40 m) (mrem/yr/Ci)[c]	Offsite Projected Dose (>40 m) (mrem/yr)	Onsite Projected Dose (>40 m) (mrem/yr)
Total α (as ^{241}Am)[d]	1.5E–06	7.5E–04	7.2E+00	1.10E+01	5.40E–03	8.25E–03
Total β (as ^{137}Cs+D)[d]	2.00E–04	1.00E–01	1.50E–01	2.10E–01	1.5E–02	2.10E–02
				Total dose (mrem/yr) ▶	2.04E–02	2.93E–02

[a] Collection efficiency reported as 99.5 percent in ANL-7683, "Sand-Bed Filtration of Aerosols: A Review of Published Information on their Use in Industrial and Atomic Energy Facilities," Argonne National Laboratory, June 1970, pp. 36 & 40. The treatment factor for sand filters is reported as the inverse of 1–0.998 (i.e., 500) in WHC-EP-0498, "Unit Dose Calculation Methods and Summary of Facility Effluent Monitoring Plan Determinations," November 1991, pp. 4–5.

[b] Quantity released obtained as maximum emission (Ci/yr) from annual reports, 1997-2006 (10 yrs—see below for emission results for the past 10 years).

[c] DOE/RL-2006-29, Rev. 0, "Calculating Potential-to-Emit Radiological Releases and Doses," May 11, 2006, Table 4-10, pp. 4-43 & 4-46

[d] ^{241}Am and ^{137}Cs+D were used as conservative estimates of total α and β respectively. The nuclide plus daughter was used for ^{137}Cs. "Plus daughter" indicates that factors from in-growth are also included; again, a conservative estimate.

	Quantity Release Data (Ci)									
	2006[a]	2005[b]	2004[c]	2003[d]	2002[e]	2001[f]	2000[g]	1999[h]	1998[i]	1997[j]
Emissions (total α)[k]	2.2E–07	ND	3.4E–07	ND	ND	6.7E–08	4.0E–07	1.5E–06	3.6E–07	8.1E–07
Emissions (total β)[k]	2.5E–05	5.0E–06	4.8E–05	9.7E–06	1.3E–05	3.5E–05	4.8E–05	1.6E–04	7.2E–05	2.0E–04

[a] DOE/RL-2007-01, p. 2-9 [b] DOE/RL-2006-01, p. 2-8 [c] DOE/RL-2005-06, p. 2-8 [d] DOE/RL-2004-09, p. 2-8
[e] DOE/RL-2003-19, p. 2-9 [f] DOE/RL-2002-20, p. 2-12 [g] DOE/RL-2001-32, p. 2-12 [h] DOE/RL-2000-37, p. 2-14
[i] DOE/RL-99-41, p. 2-12 [j] DOE/RL-98-33, p. 2-11 [k] ND = not detectable

Table 1. Unabated and Abated Dose Calculations for Fugitive and Stack Emissions.

PTE for Fugitive Emissions									
	Assumed isotope	Average (Ci/container)	Containers/ year	Estimated possession quantity (Ci/year)	Release factor	Unabated release rate (Ci/year)	Onsite unit dose factor (mrem/Ci)	Unabated dose (mrem/year)	Abated dose (mrem/year)
Alpha emitters	Am-241	1.25	13,650	17,062	2.00 E-09	3.41 E-05	1.71 E+01	5.84 E-04	NA
Beta emitters	Sr-90	18.75	13,650	255,937	2.00 E-09	5.11 E-04	7.00 E-03	3.58 E-06	NA
Total Curies/container		20.00							
Totals						5.45 E-04		**5.88 E-04**	NA

PTE for Process Area									
	Isotope	Average Ci/container	Containers/ year	Estimated possession quantity (Ci/year)	Release factor	Unabated release rate (Ci/year)	Onsite unit dose factor (mrem/Ci)	Unabated dose (mrem/year)	Abated dose (mrem/year)
Alpha emitters	Am-241	1.25	8,000	10,000	1.00 E-03	1.00 E+01	1.12 E+01	1.12 E+02	5.6E-02
Beta emitters	Sr-90	18.75	8,000	150,000	1.00 -03	1.50E+02	4.56 E-03	6.84 E-01	3.42E-04
Total curies/container		20.00							
Totals						1.60 E+02		**1.13 E+02**	**5.63 E-02**

Ci = curie
mrem = millirem
NA = not applicable
PTE = potential to emit

A4 300 AREA

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POTENTIAL-TO-EMIT RADIONUCLIDES ESTIMATE

Facility: 340 Building EMP 6/25/07
Release height (m): 9.2

Discharge Point: **340 Decon**
Number of HEPA filter banks (n): **2**

Decon Area Floor						
Radionuclide	Floor surface area	Surface Contamination[a] (dpm/100 cm²)	Appendix D Release Fraction[b]	Potential Curies Released (Ci)	Offsite Dose Factor[c] (west) (mrem/yr/curie)	Offsite Potential Dose (west) Mrem/yr
Total Beta (Sr-90)	(42'8" x 40') (0.0929 m²/ft²) = 158.6 m²	100,000	0.001	7.1 E-7	1.9E+00	1.4 E-6
Total Alpha (Am-241)		2000	0.001	1.4 E-8	2.2E+02	3.1 E-6

Sump Liquid						
Radionuclide	Sump water volume (3' x 3' x 3')	Water Sample Results (pCi/Liter)	Appendix D Release Fraction[b]	Potential Curies Released (Ci)	Offsite Dose Factor[c] (west) (mrem/yr/curie)	Offsite Potential Dose (west) Mrem/yr
Total Beta (Sr-90)	765 Liters	4.6 E+5	0.001	3.5 E-7	1.9E+00	6.7 E-7
Total Alpha (Am-241)		3.9 E+3	0.001	3.0 E-9	2.2E+02	6.6 E-7

Sump Wall						
Radionuclide	Dry Sump Wall + Floor Surface Area (5 x 3' x 3')	Surface Contamination[a] (dpm/100 cm²)	Appendix D Release Fraction[b]	Potential Curies Released (Ci)	Offsite Dose Factor[c] (west) (mrem/yr/curie)	Offsite Potential Dose (west) Mrem/yr
Total Beta (Sr-90)	(5 x 3'x 3')(0.0929 m²/ft²) = 4.2 m²	100,000	0.001	1.9 E-8	1.9E+00	3.6 E-8
Total Alpha (Am-241)		2000	0.001	3.8 E-10	2.2E+02	8.4 E-8

Hood Interior						
Radionuclide	Sample Hood Dimensions (floor + 4 walls)	Surface Contamination[a] (dpm/100 cm²)	Appendix D Release Fraction[b]	Potential Curies Released (Ci)	Offsite Dose Factor[c] (west) (mrem/yr/curie)	Offsite Potential Dose (west) Mrem/yr
Total Beta (Sr-90)	(5 x 5' x 5')(0.0929 m²/ft²) = 11.6 m²	100,000	0.001	5.2 E-8	1.9E+00	9.9 E-8
Total Alpha (Am-241)		2000	0.001	1.1 E-9	2.2E+02	2.4 E-7

Total Dose =	**6.3 E-6 mrem/yr**

[a] Source: radiological survey data; all values used are greater than recent survey data.
[b] Source: 40 CFR 61 Appendix D.
[c] Source: DOE/RL-2006-29 *Calculating Potential-to-Emit Radiological Releases and Doses.*

STACK 340-NT-EX

Isotope	Total Concentration (µCi/mL)	Total Stack Flow (L/yr)	PTE (Ci/yr)	DOE/RL-2006-29 Dose Factor (mrem/Ci/yr)	PTE (mrem/yr)	% Dose Contribution
Alpha (as Am-241)	8.2E–14	3.57E+10	2.9E–06	2.2E+02	6.4E–04	**18.0**
Beta (as Sr-90)	7.0E–13		2.5E–05	1.9E+00	4.8E–05	1.3
Co-57	1.7E–14		6.1E–07	4.8E–02	2.9E–08	0.0
Co-60	1.2E–11		4.4E–04	4.1E+00	1.8E–03	**50.6**
Sb-125	3.4E–13		1.2E–05	4.4E–01	5.3E–06	0.1
Cs-134	2.3E–14		8.2E–07	1.7E+00	1.4E–06	0.0
Cs-137	3.7E–11		1.3E–03	4.4E–01	5.8E–04	**16.3**
Eu-152	3.7E–13		1.3E–05	4.0E+00	5.3E–05	1.5
Eu-154	6.9E–14		2.4E–06	3.3E+00	8.1E–06	0.2
Eu-155	5.2E–14		1.9E–06	1.3E–01	2.4E–07	0.0
Am-241	5.3E–14		1.9E–06	2.2E+02	4.2E–04	**11.7**
					Total = 3.6E–03 mrem/yr	

A5 400 AREA

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STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
RELEASE FACTORS FROM APPENDIX D SOURCE ASSESSMENT

Facility: FFTF Discharge Point: FFTF-CB-EX

Height of release (m)	Prefilter	HEPA Filters
14.3	No	0

Radionuclide	Physical/ Chemical Form	Quantity (curies)	Release Factor	Potential Quantity Released (curies)	Offsite Unit Dose Factor mrem/yr	Onsite Unit Dose Factor mrem/yr	Offsite Projected Dose (mrem/yr)	Onsite Projected Dose (mrem/yr)
Total Beta (Cs-137)	particulate	1.03E-06	1	1.03E-06	3.50E-01	8.50E-01	3.61E-07	8.76E-07
H-3	gas	3.60E+00	1	3.60E+00	3.40E-05	1.70E-05	1.22E-04	6.12E-05
Total Alpha (Pu-239)	particulate	3.13E-08	1	3.13E-08	1.20E+1	3.0E+1	3.76E-07	9.39E-07
Total Dose							1.23E-04	6.30E-05

	Emissions taken from DOE/RL-2001-32 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2000"	Emissions taken from HNF-EP-0527-9 "Environmental Releases for Calendar Year 1999"	Emissions taken from DOE/RL-99-41 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1998"	Emissions taken from DOE/RL-98-33 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1997"	Average emissions from 1997-2000 (curies)
Total Beta (Cs-137)	1.30E-06	4.30E-07	8.80E-07	1.50E-06	1.03E-06
H-3	0.88	1.4	4.2	7.9	3.60E+00
Total Alpha	0	1.50E-08	0	1.10E-07	3.13E-08

STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
RELEASE FACTORS FROM APPENDIX D SOURCE ASSESSMENT

Facility: **FFTF** Discharge Point: **FFTF-RE-SB**

Height of release (m)	Prefilter	HEPA Filters
6.1	0	0

Radionuclide	Quantity (curies)	Release Factor	Average Quantity Released (curies)	Offsite Unit Dose Factor mrem/yr	Onsite Unit Dose Factor mrem/yr	Offsite Projected Dose (mrem/yr)	Onsite Projected Dose (mrem/yr)
Total Beta (Cs-137)	1.75E-06	1	1.75E-06	3.50E-01	8.50E-01	6.13E-07	1.49E-06
Total Alpha (Pu-239)	2.45E-07	1	2.45E-07	1.20E+01	3.00E+01	2.94E-06	7.35E-06
Total Dose						3.55E-06	8.84E-06

	Emissions taken from DOE/RL-2001-32 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2000"	Emissions taken from DOE/RL-2000-37 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1999"	Emissions taken from DOE/RL-99-41 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1998"	Emissions taken from DOE/RL-98-33 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1997"	Average emissions from 1997-2000 (curies)
Total Beta (Cs-137)	1.00E-06	1.00E-06	2.90E-06	2.10E-06	1.75E-06
Total Alpha (Pu-239)	0	2.90E-07	4.90E-07	2.00E-07	2.45E-07

STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
RELEASE FACTORS FROM APPENDIX D SOURCE ASSESSMENT

Facility: **FFTF** Discharge Point: **FFTF-HT-TR**

Height of release (m)	Prefilters	Number of HEPA filter banks
8.8	No	0

Radionuclide	Quantity (curies)	Release Factor	Average Quantity Released (curies)	Offsite Unit Dose Factor (mrem/yr/curie)	Onsite Unit Dose Factor (mrem/yr/curie)	Offsite Projected Dose (mrem/yr)	Onsite Projected Dose (mrem/yr)
Total Beta (Cs-137)	3.03E-07	1	3.03E-07	3.50E-01	8.50E-01	1.06E-07	2.57E-07
Total Alpha (Pu-239)	4.93E-09	1	4.93E-09	1.20E+01	3.00E+01	5.91E-08	1.48E-07
Total Dose						1.65E-07	4.05E-07

	Emissions taken from DOE/RL-2001-32 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 2000"	Emissions taken from DOE/RL-2000-37 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1999"	Emissions taken from DOE/RL-99-41 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1998"	Emissions taken from DOE/RL-98-33 "Radionuclide Air Emissions Report for the Hanford Site, Calendar Year 1997"	Average emissions from 1997-2000 (curies)
Total Beta (Cs-137)	7.20E-07	1.10E-07	1.60E-07	2.20E-07	3.03E-07
Total Alpha (Pu-239)	0	0	2.70E-09	1.70E-08	4.93E-09

STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
NONDESTRUCTIVE ASSESSMENT [NDA]

Facility: MASF
Release height (m): 11.7
Prefilter: ☒ Yes ☐ No

Discharge Point: **437-1-61**
Number of HEPA filter banks (n): 2

Radionuclide	Quantity (curies)	Offsite Unit Dose Factor (mrem/yr/curie)	Onsite Unit Dose Factor (mrem/yr/curie)	Offsite Projected Dose (mrem/yr)	Onsite Projected Dose (mrem/yr)
Cs-137	5.60E-07	3.50E-01	8.50E-01	1.96E-07	4.76E-07
Total Dose				1.96E-07	4.76E-07

STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
NONDESTRUCTIVE ASSESSMENT [NDA]

Facility: MASF
Release height (m): 9.1
Prefilter: ☒ Yes ☐ No

Discharge Point: 437-MN&ST
Number of HEPA filter banks (n): 2

Radionuclide	Quantity (curies)	Offsite Unit Dose Factor (mrem/yr/curie)	Onsite Unit Dose Factor (mrem/yr/curie)	Offsite Projected Dose (mrem/yr)	Onsite Projected Dose (mrem/yr)
Cs-137	7.69E-05	3.50E-01	8.50E-01	2.69E-05	6.54E-05
Co-60	1.30E-04	3.60E-01	9.50E-01	4.68E-05	1.24E-04
Mn-54	0.2	2.40E-02	6.40E-02	4.80E-03	1.28E-02
Total beta (Cs-137)	7.80E-05	3.50E-01	8.50E-01	2.73E-05	6.63E-05
Total alpha (Pu-239)	2.00E-05	1.20E+01	3.00E+01	2.40E-04	6.00E-04
Total Dose				5.14E-03	1.37E-02

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A6 600 AREA

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STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
40 CFR 61, APPENDIX D

Facility: WSCF
Release height (m): 7.6
Prefilter: [X]Yes ☐ No

Discharge Point: 696-W-1
Number of HEPA filter banks (n): 1

Radionuclide	Annual Possession Quantity (Ci/yr)	Offsite Unit Dose Factor (mrem/yr/curie)	Onsite Unit Dose Factor (mrem/yr/curie)	Offsite Potential Dose Mrem/yr	Onsite Potential Dose Mrem/yr
Sr^{90}	6.80E-03	8.80E-02	1.10E-02	5.98E-04	7.48E-05
Pu^{239}	3.30E-04	6.40E+00	1.10E+01	2.11E-03	3.63E-03
Total Dose				2.71E-03	3.70E-03
Used 200 West values					

STACK ASSESSMENT FOR 40 CFR 61, SUBPART H
40 CFR 61, APPENDIX D

Facility: WSCF
Release height (m): 9.6
Prefilter: [X] Yes ☐ No

Discharge Point: 696-W-2
Number of HEPA filter banks (n): 1

Radionuclide	Annual Possession Quantity (Ci/yr)	Offsite Unit Dose Factor (mrem/yr/curie)	Onsite Unit Dose Factor (mrem/yr/curie)	Offsite Potential Dose Mrem/yr	Onsite Potential Dose Mrem/yr
Sr^{90}	6.80E-03	8.80E-02	1.10E-02	5.98E-04	7.48E-05
Pu^{239}	3.30E-04	6.40E+00	1.10E+01	2.11E-03	3.63E-03
Total Dose				2.71E-03	3.70E-03
Used 200 West values					

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